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DEPARTMENT OF NATURAL RESOURCES

RADIOACTIVE DEPOSITS IN CALIFORNIA

SPECIAL REPORT 49

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RADIOACTIVE DEPOSITS IN CALIFORNIA

By GEORGE W. WALKER, TOM G. LOVERING, and HAL G. STEPHENS
Geological Survey, U. S. Department of the Interior

Price 50¢

RADIOACTIVE DEPOSITS IN CALIFORNIA *

By George W. Walker,† Tom G. Lovering,†
and Hal G. Stephens **

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ABSTRACT

nnaissance examination of many areas, mine properties, and cts in California during the period between 1948 and 1954 logists of the U. S. Geological Survey and the U. S. Atomic y Commission has confirmed the presence of radioactive ma- in place at more than 92 localities. Abnormally high radio- y at these localities may be caused by concentrations of y or secondary uranium minerals, radon gas, radium, or n minerals. Of the known radioactive deposits, only 8 are t to contain uranium oxide (uraninite or pitchblende), 4 a uranium-bearing niobate, tantalate, or titanate minerals, tain secondary uranium minerals, such as autunite, caruo- nd torbernite, 3 contain radon gas, 11 contain thorium mate- and, at the remaining localities, the source of the anomalous ion was not determined.

nium oxide has been tentatively identified at the Rathgeb (Calaveras County), the Embree property (Kern County), rih group of claims and the Thum Bum claim (San Bernar- County), and the Rainbow claim (Madera County). Second- anium minerals are largely confined to the arid desert regions tern and southeastern California including deposits in Lassen, Bernardino, Kern, Inyo, and Imperial Counties, although l important deposits, including the Miracle mine, are in the rn Sierra Nevada near Miracle Hot Springs in northern County. Uranium-bearing (niobate), tantalate, or titanate als have been reported from pegmatitic and granitic rock in astern and eastern California.

rium minerals have been found in vein deposits in eastern Bernardino County and in pegmatites and granitic rocks in s parts of southeastern California; placer concentrations of m minerals are known from nearly all areas in the state that derlain, in part, by granitic rocks.

primary uranium minerals occur principally as minute ory crystals in pegmatites or granitic rock, or with base-metal e minerals in veins. Thorium minerals also occur as accessory ls in granitic rock, in placer deposits derived from such rock, t Mountain Pass in veins containing rare-earth minerals. Secondary uranium minerals have been found as fracture coatings and as disseminations in various types of wall rock, particularly in areas of Tertiary volcanic rocks. The uranium deposits in California probably are related genetically to felsic crystalline and felsic volcanic rocks; the distribution of the secondary uranium minerals has been controlled, in part, by circulating ground waters and probably, in part, by magmatic waters related to the Tertiary volcanic activity. The thorium minerals are genetically related to the intrusion of granitic rocks.

Only one of the uranium deposits in California, the Miracle mine, has shipped as much as a carload of commercial grade uranium ore as of December 1954. The commercial production of thorium minerals probably will be possible only if these minerals can be recovered cheaply as a by-product either from the mining of rare-earth minerals at Mountain Pass or from the placer mining for gold.

blication authorized by the Director, U. S. Geological Survey
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Energy Commission and is published with permission of the
Commission.
S. Geological Survey, Denver, Colorado.
S. Geological Survey, Menlo Park, California.

INTRODUCTION

Since 1948, a large number of mine properties, prospects, placer deposits, and claims have been examined for anomalous radioactivity by geologists of the U. S. Geological Survey and the U. S. Atomic Energy Commission. In addition, collections of ore and rock specimens from many other properties have been tested for radioactivity, and many hundreds of miles of traverses have been made by automobile, particularly in the Mojave Desert region. The tests of ore and rock specimens and the traverses by automobile have been largely unsuccessful in finding new occurrences of radioactive material. Examination of mine properties, prospects, placer deposits, and claims has, on the other hand, confirmed the presence of radioactive minerals at more than 92 different localities in California.

This report briefly describes the deposits of radioactive minerals in California. Where the information is available, the location, ownership, development, geology, mode of occurrence, and grade of samples are described for each deposit that was examined prior to December 31, 1954. Much of the field work has been of a reconnaissance nature; therefore, detailed information concerning many of the deposits is lacking. A few radioactive deposits, because of their scientific or possible economic significance, have been studied in more detail.

This report is based largely on field investigations of radioactive material in California made by the U. S. Geological Survey and the U. S. Atomic Energy Commission between 1948 and 1954. Part of the information has been obtained from published references, and part of the information is from data obtained by C. W. Chesterman of the California Division of Mines; by F. H. Main, F. M. Chace, R. U. King, D. F. Hewett, W. N. Sharp, D. R. Shawe, and D. G. Wyant of the U. S. Geological Survey; and by E. E. Thurlow, C. C. Towle, Jr., D. L. Everhart, W. A. Bowes, and H. E. Nelson of the U. S. Atomic Energy Commission.

Most of the properties described in the report have been examined by the writers. Most of the field work and the preparation of this report was done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

Chemical analyses for the uranium content of samples collected by the U. S. Geological Survey were made by the Denver and Washington, D. C., laboratories of the

Table 1. Radioactive minerals reported from California.

Name	Chemical composition [a]	Uranium [a] (percent)	Thorium [a] (percent)	Megascopic appearance	Locality
Allanite	$(Ca, Ce, Th)_2(Al, Fe, Mg)_3 Si_3O_{12}(OH)$	0.02	<3.2	Prismatic, orange-brown to black crystals	Rock Corral, Yosemite Park.
Autunite (meta-autunite I has $2\frac{1}{2}$-$6\frac{1}{2}H_2O$)	$Ca(UO_2)_2(PO_4)_2 10\text{-}12H_2O$	45-48	----	Yellow-green, fluorescent, tabular crystals	Miracle mine, Verdi property, Chilson proj
Betafite(?)	$(U, Ca)(Nb, Ta, Ti)_3O_9 \cdot nH_2O$	16.3-24.5	1.0-1.1	Green-brown, brittle isometric crystals	Hoerner-Ross property
Brannerite	$(U, Ca, Fe, Y, Th)_3Ti_5O_{16}$?	39.3	3.6	Brownish-black prismatic crystals	Mono County near Cole
Carnotite	$K_2(UO_2)_2(VO_4)_2 3H_2O$	52.8-55.0	----	Lemon yellow, locally micaceous, powdery	Vanuray and Lucky Sti Kramer Hill
Cyrtolite	$ZrSiO_4$-U, Y, Th, and R. E.	<1.4	?	Transparent, reddish tetragonal crystals	Hoerner-Ross property
Davidite	Near $Fe^2(Fe^3,Ce)_2Ti_6O_{17}$-R.E. and UO_2	4.4	0.12	Black, opaque anhedral grains and hexagonal plates	Sierra Nevada near Bish
Euxenite	$(Y,Ca,Ce,U,Th)(Nb,Ta,Ti)_2O_6$	3-9	<4.3	Black prismatic crystals	Rock Corral area
"Gummite"	Variable	40-80?	?	Red, waxy, brittle	Jumpin claim, Rosamond
Monazite	$(Ce,La,Th)PO_4$	----	<26.4	Yellow, red, brown, transparent crystals, commonly tabular	Live Oak Tank are Corral area
Metazeuneritc	$Cu(UO_2)_2(AsO_4)_2 \cdot 8H_2O$	46.4	----	Grass green, commonly tabular crystals	Truckee Canyon group, County, Perry Jone Plumas County
Pitchblende(?) (Massive form of uraninite)	Between UO_2 and U_3O_8	55-83	----	Black pitchy masses, powdery	Yerih group, Rainbow cl
Samarskite	$(Y,Ce,U,Ca,Fe,Pb,Th)(Nb,Ta,Ti,Sn)_2O_6$	8.4-16.1	<3.7	Black, dull, prismatic crystals	Rock Corral area
Thorite	$ThSiO_4$	<9	25-63	Black-brown, glassy isometric crystals—Uranoan variety round green grains	Mountain Pass area Sierr
Torbernite (meta-torbernite has $8H_2O$)	$Cu(UO_2)_2(PO_4)_2 8\text{-}12H_2O$	47.1-50.8	----	Green tabular crystals	Chilson prospect, Luc claim? Perry Jones gro
Uraconite(?) (obsolete)	Uranium sulfate	?	----	--------	Rathgeb mine
Uraninite	UO_2	<88	<44	Black, acicular, or cubic crystals	Rathgeb mine, Breckenri tain area, Kern Count
Xenotime	YPO_4	<3.6	<2.2	White, brown red, resinous, tetragonal crystals	Live Oak Tank area
Yttrocrasite(?)	$(Y,Th,U,Ca)_2Ti_4O_{11}$?	2.3	7.7	Black tabular crystals	Riverside Co. (see Murc Webb, 1948, p. 318)
Zircon	$ZrSiO_4$	<2.7?	<13.1?	Translucent, colorless or yellowish, prismatic crystals	Rock Corral area

[a] Frondel and Fleisher (1952).

Geochemistry and Petrology Branch of the Geological Survey. This work was also done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

RADIOACTIVE DEPOSITS

Many deposits of uranium- and thorium-bearing minerals are known in eastern and southern California, but as of December 1954, only one deposit (the Miracle mine) has made as much as a railway shipment of uranium ore; both uranium and thorium are scarce in northern California. Most of the uranium deposits are in the southern Sierra Nevada and the Mojave Desert region of southern California. Thorium deposits are confined to the Mojave Desert region.

Although more than 20 different radioactive minerals have been reported from California, only a few of these contain sufficient uranium or thorium to be classed as potential ore minerals. Two classes of radioactive minerals—principally uranium-bearing and principally thorium-bearing—are described in the following pages.

Uranium Deposits

Distribution. Although deposits of uranium-bearing minerals are known from widely scattered localities throughout California, most of them occur in the southern part of the Sierra Nevada and in the Mojave Desert physiographic provinces. The deposits are closely grouped in places, particularly in the vicinity of Kern River Canyon northeast of Bakersfield and in the Mojave Desert near the town of Mojave. Other clusters of uranium prospects include those in eastern I County and southeastern Lassen County and in v Kern County near Taft and McKittrick.

The Kern River Canyon deposits are characteri near surface concentrations of autunite along fr in granodiorite and in weathered granitic rock ac to the fractures. The Mojave Desert deposits are c terized by the occurrence of secondary uraniun erals, which include autunite, meta-autunite, torb and carnotite, along fractures and bedding pla mid-Tertiary sedimentary or volcanic rocks.

Deposits of primary uranium minerals seem to common and more widely scattered throughout th than the deposits of secondary uranium mineral may be due, in part at least, to the difficulty of id ing the dark-brown to black primary minerals, s pitchblende, in a deposit, whereas the vividly c secondary minerals stand out in sharp contrast. quantities of uraninite have been identified at the doned Rathgeb gold mine (Rickard, 1895), Cal County, and are thought to be present at the Gree claims (Truckee Canyon group), Nevada County, the Thum Bum claim near Big Bear Lake, San B dino County. Other primary uranium minerals, i ing samarskite, euxenite, davidite, and brannerite been identified in crystalline rocks and in placer de in east-central and southeastern California.

Size and Shape. Most of the deposits containin ondary uranium minerals are small, rarely exc 100 feet in their greatest dimension. The deposits

sierable variety in shape, but the majority are
ly tabular. Commonly, the secondary uranium min-
are erratically distributed on joint surfaces adja-
o mineralized faults; deposits of this type are
ially tabular in the plane of the fault and range
n few inches to 10 feet in width and commonly do
ceed 100 feet in length. Nearly horizontal, roughly
ilar deposits are present where the secondary ura-
minerals coat bedding planes of sedimentary rocks
e erratically disseminated through porous portions
rock adjacent to these bedding planes. Deposits of
ype rarely exceed 50 feet in their greatest dimen-
nd commonly are not more than a few feet thick.
econdary uranium minerals commonly occur in
disconnected patches.

t's difficult to make any generalizations about the
nd shape of primary uranium deposits in Cali-
. Most of the primary uranium minerals occur as
minated accessory constituents in granitic rocks;
gle crystals, or locally, as small aggregates with
minerals in pegmatites; and as clots of crystals in
containing base-metal sulfides.

calization. The uranium deposits in California
e subdivided into four groups on the basis of their
of occurrence. These are: (1) deposits in fissure
(2) deposits on minor fractures, bedding planes,
ocally, as disseminations in porous rock, (3) re-
ment deposits, and (4) deposits representing rela-
oncentrations of radioactive minerals in granitic
or pegmatites. Only at the Rathgeb mine has a
ry uranium mineral (uraninite) been found in
ation with a secondary uranium mineral (uraco-
?). Of the 81 uranium deposits described in the
ing pages, only 8 are thought to have been local-
ntirely by primary hydrothermal solutions. The
ining 73 deposits contain either secondary uranium
als or unidentified uranium-bearing minerals asso-
with secondary base-metal minerals; the uranium
se deposits was probably introduced, or at least
ributed, by circulating ground water or late hydro-
al solutions.

nium in quartz fissure veins generally has limited
rratic distribution. Whether present as a primary
ondary mineral, uranium is commonly mixed with
metal sulfides or their oxidation products. Nearly
the deposits of this type have been found in gra-
rocks. Examples of uranium in quartz fissure veins
le the Rathgeb mine, the Rademacher, Rainbow,
Red Devil claims, the Wild Bill group, the Pay-
r mine, and the Perry Jones claims.

e largest group includes those deposits in which
dary uranium minerals coat fractures or bedding
s. The country rock of such deposits is diversified;
y the wall rock may be bleached and partly altered
drothermal clay minerals; it may consist of Ter-
r continental sedimentary rocks, in part tuffaceous,
r example the Rosamond prospect; it may be Ter-
r volcanic rocks such as found on the Chilson prop-
y or it may be older crystalline rocks as on the
rty and Baxter properties.

mmonly, the greatest concentration of secondary
ium minerals is in fault gouge or on joints or bed-
planes adjacent to faults. Deposits in bedded sedi-
ary rocks seem to be confined largely to certain
individual beds; the reasons for selective deposition of uranium in these beds are not fully understood, although porosity, permeability, and $CaCO_3$ content play a significant part.

A third group includes deposits in which base-metal sulfide bodies, containing uranium, replace limestone along fractures in the rock. At the Yerih group of claims (Scotty Wilson property), San Bernardino County, a finely divided uranium mineral is intermixed with base-metal sulfides that occur as irregular masses and thin seams erratically distributed in limestone. Uranium has also been found with wulfenite in oxidized ore bodies composed largely of primary and secondary lead and zinc minerals at the Lippincott and Ubehebe mines in Inyo County. At both properties, the base-metal sulfiide ore bodies have, in part, replaced the limestone and have also filled fractures.

Uranium-bearing minerals in crystalline rock have been concentrated and localized only in the sense that they may be more prevalent in some places in the rock than in others. At the Hoerner-Ross deposit, cyrtolite and betafite (?) are sparsely distributed in small pockets or clots in a thin zone in a pegmatite; at the Pomona Tile quarry in the Rock Corral area, samarskite and euxenite occur sparingly in small iron-stained patches in the pegmatite.

Mineralogy. Uranium-bearing minerals reported from California can be divided into a group of primary minerals, including uraninite (or pitchblende ?), brannerite, samarskite, betafite, and euxenite, and a group of secondary minerals including autunite, torbernite, carnotite, and gummite (?). The primary minerals are considered to be original constituents of quartz veins containing sulfide minerals and of granitic rocks or pegmatites. The secondary uranium minerals are derived from the alteration of the primary minerals; in most secondary deposits in California, however, primary uranium minerals have not been found with the secondary.

According to Rickard (1895, p. 329), uraninite (uranous oxide) and uraconite (a name originally proposed for an ill-defined yellow uranium ochre, supposedly uranium sulfate) occur together at the Rathgeb mine in Calaveras County associated with gold in a quartz fissure vein. As described by Rickard, the uraninite consists of acicular black crystals. On the Rainbow claim, Jackass district, Madera County, minute quantities of an unidentified uranium mineral occur in a smoky quartz vein associated with pyrite, chalcopyrite, tetrahedrite (?), bornite (?), and magnetite; the uranium mineral is probably uraninite. Minute particles of a primary uranium mineral, probably uraninite, are disseminated through galena and sphalerite on the Yerih group of claims, Holcomb Valley district, near Big Bear Lake in San Bernardino County.

Primary uranium-bearing rare earth niobates, tantalates, and titanates including such minerals as brannerite, samarskite, betafite, and euxenite have been found as accessory minerals in pegmatites and granitic rocks and as minor constituents of black sand concentrates. According to Pabst (1954), brannerite occurs as an accessory mineral in plutonic rocks exposed about 7 miles south of Coleville in Mono County. Betafite (?) and cyrtolite described herein have been reported by Hewett (personal communication) from pegmatites

exposed on the Hoerner-Ross property, San Bernardino County, and samarskite and euxenite have been found in pegmatites exposed in the Pomona Tile quarry near Rock Corral, San Bernardino County. Murdoch and Webb (1948) have described other deposits of some of these rare uranium-bearing minerals.

Shawe (personal communication) has reported uranium-bearing ilmenite, which is questionably related to the mineral davidite, from granitic rocks and placer concentrates on the east slope of the Sierra Nevada in the vicinity of Bishop. The mineral occurs as black, anhedral grains and as hexagonal plates which have optical properties similar to those of ilmenite. Chemical tests indicate that the ilmenite contains iron, titanium, manganese, cerium group of rare earths, vanadium, thorium, and uranium.

The secondary uranium minerals, autunite, torbernite, meta-zeunerite (?), "gummite" (?), and carnotite have been identified from localities in the desert region of southeastern California, in the Kern River Canyon area (Kern County), and in the eastern parts of Plumas and Lassen Counties. At some properties only one of these minerals is present, whereas at other properties two or more are associated.

Autunite, a hydrated phosphate of calcium and uranium, occurs characteristically as pale yellow-green or lemon yellow, square basal plates as much as a millimeter in size; all the autunite is fluorescent in shades of yellow-green. Torbernite, a hydrated phosphate of copper and uranium, occurs as green, essentially non-fluorescent, square or rectangular basal plates which commonly are foliated. Most of the basal plates are extremely small, though a few are as much as a millimeter or larger in size. Metazeunerite (?) occurs at the Perry Jones claims, Plumas County and at the Truckee Canyon group as small, grass-green, tabular crystals. It is associated with torbernite, and fills minute cavities and fractures in quartz veins.

Small quantities of "gummite" (?), a brittle and waxy, dark reddish-brown to black mineral, are found on slickensided fault surfaces at the Rosamond prospect, Kern County. It is associated with autunite, hydrated iron oxides, chlorite (?), and an unidentified dark green waxy mineral. Small specimens containing this assemblage are more highly radioactive than normally would be expected from the small amount of autunite that is present. In this report the waxy minerals are called gummite (?), as the physical properties are similar to those for gummite described in Dana's *System of Mineralogy* (Palache, Berman, and Frondel, 1952, p. 622-623). "Gummite" is a field term applied to substances that are essentially oxides of uranium, commonly with lead, thorium, and H_2O, but whose true identity is unknown. The origin of the waxy minerals at the Rosamond property is unknown; primary uranium minerals were not observed on the property nor have any been identified from the surrounding area. The anomalous radioactivity of the material might be due to abundant submicroscopic particles of autunite disseminated through an unidentified mineral. Carnotite, the hydrous potassium uranium vanadate, occurs principally as a lemon yellow aggregate of crypto-crystalline material which, locally, consists of sparse micaceous plates as much as a millimeter in size. At a few places carnotite forms a thin coating of yellow, dust-like particles on joint surfaces.

Autunite and gummite (?) occur with iron an ganese oxides, chlorite (?), and opal at the Ros prospect, Kern County; at the Chilson proper tunite and torbernite occur as flakes and cryptoc line coatings on joint surfaces; and at the Luck claim, Imperial County, carnotite and autun torbernite, associated with talc, hydrothermal cla erals, manganese and iron oxides, gypsum, and are disseminated in hydrothermally altered and bl wall rock. Autunite is the dominant uranium or eral at the Miracle mine, Kern County, where it seminated in clay gouge and weathered graniti adjacent to a major northwest-trending, vertica ture. Autunite is also the principal uranium min the Buckhorn claims (southeastern Lassen Co where it coats minor fractures in rhyolitic tuff. Perry Jones claims in eastern Plumas County, torl and metazeunerite (?) associated with secondar per minerals, occur as encrustations on fractu faces and as small cavity fillings in quartz ve granodiorite. Autunite (or meta-autunite ?) is th conspicuous secondary uranium mineral in the S mining district a few miles northwest of Rosa Kern County, where at least nine uranium depos grouped. The deposits appear to be along fractu sedimentary or volcanic rocks of Tertiary age quartz monzonite of Jurassic (?) age which, loca pegmatitic. At the Harvard Hills, east of Yerm tunite coats fractures in layered tuffaceous sedim rocks, black chert, marly sandstone, and lim Autunite and unidentified secondary uranium mi are associated with quartz and clay minerals in a granite at the Rafferty property in Los Angeles C Secondary uranium minerals are also reported fr Paymaster mine in the Solo district, although n are available as to the mineralogy of this occu and from the Taft-McKittrick area in Kern C where they are associated with siltstone and sh late Miocene age. Other deposits, as for examp Vanuray claim and Kramer Hills deposits, c carnotite associated with clay, opal, and oxides o and manganese in bedded clays and marls of M age.

Grades. Most of the known deposits of urani California are low in grade. Much of the sampl contained in the descriptions of radioactive depo this report are the result of assays of select spe collected by personnel of the U. S. Geological S and of the U. S. Atomic Energy Commission o mitted to those agencies by prospectors; these sa are not to be interpreted as representative of t posit from which each was collected.

The Miracle mine in Kern River Canyon, County, shipped a railway carload (46 tons) of ur ore averaging 0.62 percent U_3O_8 to the Vitro Ur Company plant in Salt Lake City, Utah, in August this is the only mine, as of December 1954, to m carload shipment of uranium ore from Cali (Anonymous, 1954).

Origin. The uranium deposits in California a netically related to the intrusion of granitic rock a as to Tertiary volcanic activity. Studies have ind that most of these deposits are in either of two en

(1) pre-Tertiary pegmatites, granitic rocks, and quartz veins in which primary uranium minerals been found, and (2) Tertiary volcanic, near-surtrusive, pyroclastic, and tuffaceous sedimentary in which many of the deposits of secondary m minerals occur.

anium-bearing minerals in pegmatites, such as at the Hoerner-Ross property, at the Pomona Tile r, and elsewhere, are probably primary constitof the pegmatite. Likewise, uranium-bearing acminerals in bodies of granitic rock are primary stituents of the rock. The uranium-bearing minerals he base-metal sulfide minerals found at the Yerih of claims and at the Rainbow claim, probably from the same hydrothermal solutions that deit the sulfides.

primary source of the uranium in the deposits aining secondary minerals is more difficult to ascerhe mineralogy as well as the nature of the host are different from place to place, although the host st many deposits are mid-Tertiary extrusive or in- volcanic rocks, or sedimentary beds containing astic material. The secondary uranium minerals, s autunite, torbernite, carnotite, and gummite are if ever, formed directly from hot aqueous solumanating from a cooling magma. The uranium in minerals has been derived from primary minerals ere leached and dissolved either by ground waters hydrothermal solutions. The dissolved uranium in ground waters was re-deposited wherever a change chemical or physical environment caused a de- in the solubility of the uranium. Secondary hyoxides of uranium, such as gummite, may form on rface of primary pitchblende or may be deposited solution at a considerable distance from their . The phosphates, autunite, and torbernite have ound in close proximity to primary uranium deelsewhere, but in California they occur in areas from any of the known primary occurrences of m. Vanadates, such as carnotite, are not comfound close to primary uranium minerals alseveral such associations have been reported from olorado Plateau area by Weeks and Thompson p. 20). Primary uranium minerals have been in very few deposits containing secondary uraniminerals so that the relationship of these minerals well known. However, many of the secondary ts occur in rocks derived from Tertiary volcanic y and, locally, some of the felsic flows and near- intrusives contain more uranium than other exposed in the same area. It seems reasonable to that the uranium now in the secondary minerals en derived by the leaching and solution of primary stituents of the volcanic rock. Some of the uranium e derived, however, through the leaching and solu- f primary minerals in rocks other than the vol- by late hydrothermal solutions that accompanied lcanic activity. Evidence of hydrothermal activity s either contemporaneous with, or later than the aic activity, is apparent at the Lucky Star, Van- and Jumpin claims, and elsewhere; at all of these rties, the wall rocks, which are in part either mid- ry volcanic or tuffaceous sedimentary rock, are ed and partly altered to hydrothermal clay min- In addition, some of the secondary uranium minerals found in areas of altered wall rock are intermixed with hyalite opal.

Thorium Deposits

Thorium-bearing minerals have been reported from nearly all sections of California; they occur sparingly in most felsic plutonic crystalline rocks, in some metamorphic rocks, in some pegmatites, and in veins; numerous placers containing thorium minerals are also known throughout the state. Minerals that are classed as thorium-bearing for purposes of this report include: monazite, thorite, xenotime, and allanite. Thorium occurs as a major or minor constituent in these minerals, commonly in combination with uranium and the rare earths of the cerium group.

Distribution. Thorium minerals occur in many places throughout the state, but the recent studies have been limited mainly to a few localities; these include the Mountain Pass and the Rock Corral areas in San Bernardino County, and the Live Oak Tank area and the Desert View claim in Riverside County. At Mountain Pass, in the northeastern Mojave Desert, thorite is associated with bastnaesite, a rare earth fluocarbonate, in vein deposits. In the same area, monazite crystals are disseminated in a mass of rock composed dominantly of calcite, barite, quartz, and bastnaesite. Thorium-bearing allanite, monazite, and radioactive zircon are disseminated in porphyritic quartz monzonite and in metasomatically altered inclusions in the quartz monzonite at the Rock Corral area. At the Black Dog claim, about 3 or 4 miles south of Rock Corral, a vein composed in part of thorium-bearing monazite and allanite is enclosed in crushed gneiss. At the Original claim small amounts of monazite (?) are an accessory mineral in crystalline rocks. At the Live Oak Tank area monazite occurs in black sands and with xenotime in pegmatite. At the Desert View claim, central Riverside County, small amounts of monazite occur in biotite gneiss. In addition, there are numerous published and unpublished references to thorium minerals in pegmatites in southern California, in granitic rocks in the Sierra Nevada, in black sand lenses along Pacific Ocean beaches, and in placer gravels along rivers flowing from the Sierra Nevada and the Klamath Mountains.

Mineralogy. Thorium-bearing minerals reported from California include thorite, monazite, allanite, and xenotime. At most places these minerals occur only in small quantities and as minute grains; megascopic identification is normally impossible. Identification of the thorium minerals from nearly all the widely scattered localities is based on microscopic examination, x-ray, spectographic, or chemical analysis.

Thorite has been identified at the Mountain Pass area, in placer concentrates collected near Bishop, in coastal beach sands south of San Francisco, and in placer concentrates collected along the west slope of the Sierra Nevada (George, 1951, p. 131). It occurs in two main varieties. One variety, distinguished from the common variety because of its uranium content, is called uranoan thorite and has been found as green, rounded detrital grains commonly having elongate prismatic habit. As far as is known, uranoan thorite has not been found in place. The other variety of thorite, which has been found in place at Mountain Pass, the Rainbow group of claims,

occurs characteristically as euhedral crystals and as rounded grains which are yellow-orange to brown.

Monazite, the cerium group phosphate, occurs most commonly as light to dark golden brown or reddish-brown grains which have a resinous luster. In some placer deposits, the monazite is in well-shaped prismatic crystals, whereas in other placers and in beach sands it is in subhedral tablets.

Most of the allanite reported from California has been found in granitic rocks and in pegmatites, although some placer deposits are known. Most of the allanite grains are small prismatic crystals; locally, however, prismatic crystals as much as a few inches in length have been reported. The allanite is amber to dark brown or black in color and may have a vitreous or resinous luster or, through alteration, a dull earthy luster.

Xenotime, occurring as colorless, rounded equidimensional grains in Pacific Ocean beach sands has been reported by Hutton (1952). Melhase (1936) found xenotime in pegmatite (Riverside County) as well-formed, yellowish-brown, tetragonal crystals, a maximum of ¼-inch in length.

SUGGESTIONS FOR PROSPECTING FOR URANIUM AND THORIUM

The following generalizations may be of some assistance in prospecting for uranium in California: (1) The areas in California that appear to be the most favorable for the discovery of uranium are those adjacent to known deposits in the Mojave Desert province, the southern part of the Sierra Nevada in the vicinity of the Kern River Canyon (Kern County), the northeastern part of the Sierra Nevada (eastern Plumas County and southeastern Lassen County), the San Bernardino Mountains (San Bernardino County), the Basin and Range province of eastern California, and southern California (Riverside and Imperial Counties); (2) Uranium deposits in fractures and shear zones that appear to have been formed from groundwater or hydrothermal water will most likely contain secondary uranium minerals; (3) uranium is commonly associated with areas in which the wall rocks are bleached and altered to hydrothermal clay minerals, some deposits contain introduced silica in the form of hyalite opal as fracture coatings; (4) limonite, either as stain or massive gossan, is commonly radioactive in the vicinity of secondary uranium deposits.

Uranium has been found most commonly in California as small deposits of secondary minerals erratically distributed on fractures and bedding planes in various types of rock. The secondary deposits occur most abundantly, however, in mid-Tertiary volcanic, pyroclastic, and tuffaceous sedimentary rocks and in Tertiary continental sedimentary rocks. Some secondary deposits have been found in altered and unaltered granitic rocks and in altered base-metal sulfide bodies in limestone. The source of the secondary uranium deposits has not been demonstrated conclusively, although many of the deposits are believed to have formed during periods of mid-Tertiary volcanic activity. Most of the deposits are distributed along fractures and bedding planes which have been channel-ways for groundwaters or for hydrothermal solutions.

Minerals containing uranium rarely occur with those containing thorium. Such an association is found in placers that are composed mainly of complex ref minerals that were originally scattered err through pegmatite or occurred as minute accesso tals in plutonic rocks.

Thorium minerals have been reported from parts of the state—Mountain Pass, Rock Corral a where in San Bernardino County, the western Riverside County, granitic rocks of the Sierra N stream gravels along most of the major rivers th westward from the Sierra Nevada, and beach along the Pacific Coast of northern California. Th distribution suggests that the thorium minerals a ent in small amounts in most of the granitic in rocks in the state and that careful sampling of along river draining areas where such rocks are e would probably add considerably to the list of t occurrences.

ECONOMIC EVALUATION

Studies of radioactive deposits in California sh although uranium- and thorium-bearing miner widely distributed and occur in various geologic e ments throughout the state, economic concentrat these minerals are rare. As of December 1954, o mine has made as much as a carload shipment of u ore from California and very few other properties the state might be considered as potential sou uranium ore under present conditions. A compl praisal of the uranium-bearing properties is not p however, because exploration on nearly all of th been limited to surface or near surface prospecti the character of California uranium deposits at d not known.

Thorium-bearing minerals might be economica covered as a by-product of gold dredging operat as a by-product in the recovery of rare earth m from the bastnaesite deposits at Mountain Pass. N the known thorium deposits in California can b cessfully exploited solely for thorium under prese nomic conditions.

DESCRIPTION OF THE RADIOACTIVE DEPOS

Although many localities containing concentrat radioactive material are known throughout Cali the following descriptions of individual propert limited to those that have been examined since Brief reference is made to a few deposits which, have not been studied by the U. S. Geological Su the U. S. Atomic Energy Commission. The depos listed alphabetically by counties in the accomp table and their location is shown on the location n

In the following pages the deposits are grou geomorphic provinces because many of them are in the same or similar geologic environment wi given province. The boundaries of the geomorphi inces are essentially the same as those described b kins (1941). A few deposits, for example thos Searles Station (Kern County), and near Big Bea (San Bernardino County), are only short distanc side the boundaries of the Mojave Desert provin convenience, the descriptions of these deposits a included under the Mojave Desert province headi

Mojave Desert Province

The Mojave Desert province, which includes p Kern, Los Angeles, San Bernardino, Riverside a perial Counties, in the southeastern part of the

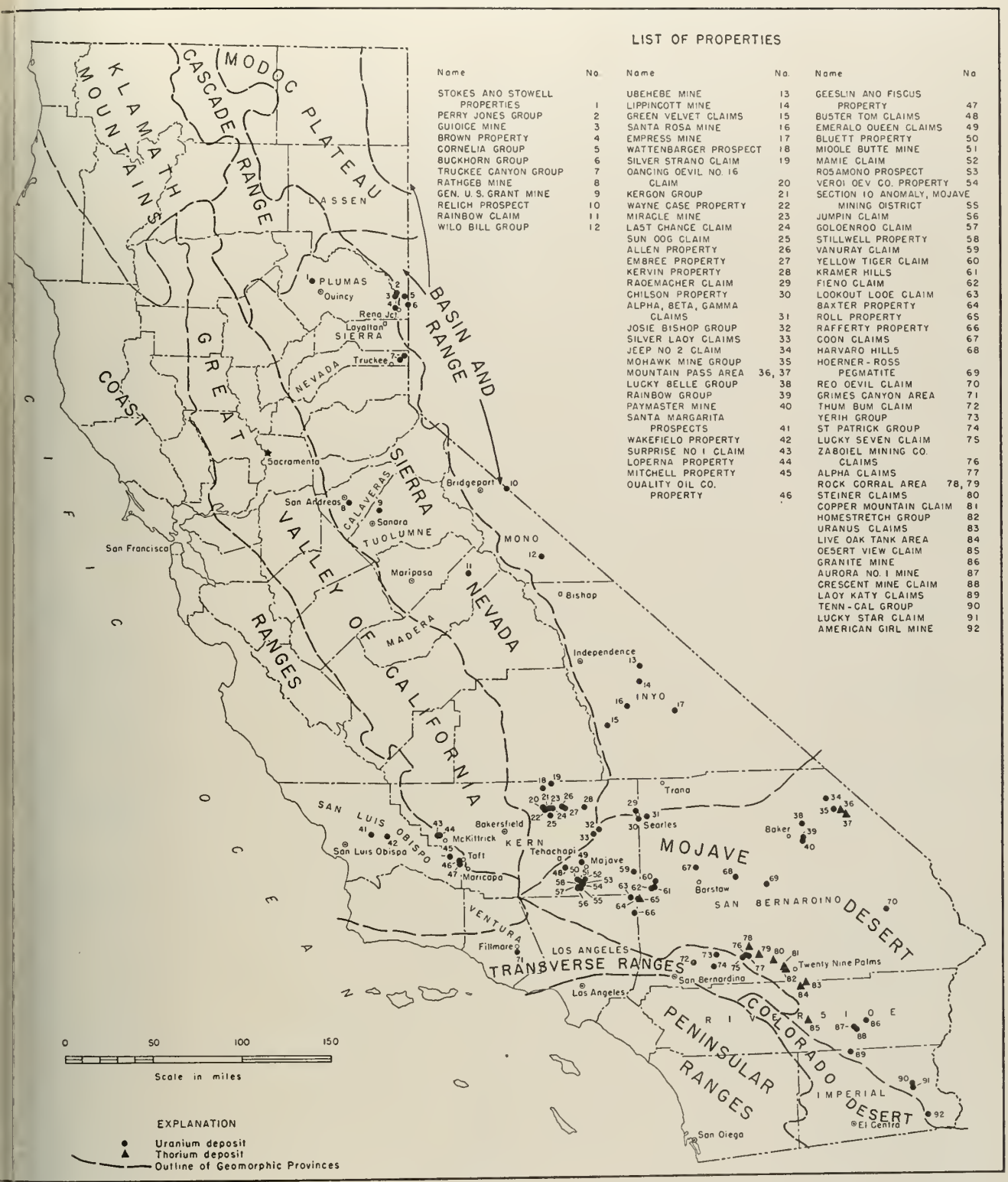

FIGURE 1. Location of radioactive deposits in California examined by geologists of the U. S. Geological Survey and the U. S. Atomic Energy Commission during the period 1948 to 1954.

Table 2. Radioactive occurrences in California (by counties).[a]

Map No.[b]		Location[c]			Type	Country rock	Radioactive mineral (s)	Other minerals	Sam (in
		Section	Township	Range					
					Calaveras County				
8	Rathgeb mine	34	4N.	12E.	Vein	Slate, amphibolite	Uraninite, uraconite	Gold, quartz	--
					Imperial County				
92	American Girl mine	18-19	15S.	21E.	Vein	Gneiss	--------	Quartz, kyanite, mica	--
89	Lady Katy group	7	9N.	14E.	Fracture coatings, disseminated	Granite, diorite	Meta-torbernite?	Quartz, Fe oxides	0.022 U_3(
91	Lucky Star claim	36?	12S.	19E.	Disseminated	Schist, quartzite felsic intrusives	Autunite?, carnotite, torbernite	Clay, talc	0.02-(
90	Tenn-Cal group	14	12S.	19E.	Disseminated	Schist	Torbernite and yellow U mineral	Kyanite, Fe and Mn oxides, gypsum	0.10-(eU$_3$
					Inyo County				
	Bonanza mine[d]	10	15S. (proj.)[e]	40E.	Replacement?	Sedimentary rocks of Paleozoic age	--------	Cu, Ag, Pb minerals, idocrase, garnet	0.016
15	Green Velvet claims	25	19S.	37E.	Disseminated	Clay, shale & sandstone	Autunite	Clay minerals, quartz (sand)	--
17	Joe McCulley property	7	18S.	44E.	Replacement	Limestone of Paleozoic age, Granite of Jurassic age	--------	Cu, Pb, Ag sulfides, tactite minerals	10X b
14	Lippincott mine	13 (proj.)	15S.	40E.	Replacement and fissure filling	Dolomite, quartz monzonite, minette of Paleozoic age	--------	Galena, sphalerite, secondary Pb and Zn minerals, Fe oxides, wulfenite	0.05 U
16	Santa Rosa mine	26, 35 (proj.)	17S.	39E.	Replacement and fissure filling	Limestone, andesite, basalt of Permian (?) age	--------	Galena, sphalerite, secondary Pb, Zn, and Cu minerals	---
13	Ubehebe mine	1, 2 (proj.)	14S.	40E.	Replacement and fissure filling	Dolomite, quartz monzonite, minette of Paleozoic age	--------	Galena, sphalerite, secondary Pb and Zn minerals, Fe oxides, wulfenite	0.05 U
	Wingate Pass area[d]	83 miles NW. of Baker			Fracture coatings	Limestone chert, rhyolite	Secondary uranium minerals	Quartz, Pb and Cu carbonates	---
					Kern County				
26	Allen property	15	27S.	33E.	Spring deposit	Granite	Radium (?) mineral	Calcite (limestone)	1.30 e 0.04
32	Josie Bishop group	30	29S.	37E.	Fracture coatings	Granite, alaskite dikes of Paleozoic age	--------	Pyrite, iron oxides, quartz	.003
50	Bluett property	9	10N.	13W.	Fracture coatings	Tuffaceous sandstone & quartz monzonite	Autunite	Limonite	---
48	Buster Tom claims	8	11N.	14W.	Fracture coatings	Granitic rock	Autunite, gummite (?)	Limonite quartz, clay	---
22	Wayne Case property	25 (?)	27S.	31E.	Fracture coatings, disseminated	Granodiorite	Secondary uranium minerals	Limonite, clay	0.47 e
30	Chilson	36 (?)	28S.	40E.	Fracture coatings, disseminated	Dacite of Tertiary age	Torbernite, autunite (?)	--------	0.121
20	Dancing Devil No. 16 claim	23	27S.	31E.	Accessory minerals in pegmatite	Pegmatite cutting granodiorite	--------	Biotite	0.25 U

Table 2. Radioactive occurrences in California (by counties)[a]—Continued.

	Location[b]			Type	Country rock	Radioactive mineral (s)	Other minerals	Sample data (in percent)
	Section	Township	Range					
Embree property	24	27S.	33E.	Disseminated	Quartzite, gneiss	Primary uranium mineral and gummite (?)	Garnet, limonite, fluorite	7.5 eU_3O_8
Emerald Queen	34 (?)	32S.	35E.	Fracture coatings, disseminated	Tuffaceous sandstone	Secondary uranium (?) minerals	Ca carbonate	0.054 U_3O_8
Geeslin and Fiscus	34 (?)	32S.	23E.	Fracture coatings	Siltstone & shale	Secondary uranium minerals	--------	0.32 U_3O_8
Goldenrod claim	4	9N.	13W.	Fracture coatings	Dacite of Tertiary age	--------	Iron oxides	0.041 U
Jumpin claim	9, 10	9N.	13W.	Fracture coatings	Rhyolite of Tertiary age	Autunite "gummite"?	Iron oxides	0.002 U—0.037 U
Kergon group	20	27S.	32E.	Fracture coating, disseminated	Granodiorite	Autunite	Clay minerals fluorite, molybdenum mineral	1.08 U_3O_8
Kervin property	23	27S.	35E.	Fracture coating	Granitic rock	Torbernite, autunite	--------	0.11 U_3O_8
Last Chance claim	22	27S.	32E.	Disseminated	Tactite, marble, granite	--------	--------	0.055 U_3O_8
Loperna property	2	30S.	21E.	Fracture coating	Siltstone and and shale	Secondary uranium minerals	Iron oxides	0.04 U_3O_8
Mamie claim	18	10N.	12W.	Fracture coating	Rhyolite	--------	--------	--------
Middle Butte mine	16	10N.	13W.	Fracture coating	Rhyolite, porphyry and tuff	Autunite, radon gas(?)	Clay minerals	0.025U
Miracle mine	20	27S.	32E.	Fracture coating, disseminations	Granodiorite	Autunite	Clay minerals	0.62 U_3O_8 (shipment)
Quality Oil Co. property	22	32S.	23E.	Fracture coatings	Siltstone and shale	--------	Iron oxides	0.06 U_3O_8
Rademacher claim	2	28S.	40E.	Vein	Granite of Jurassic age	--------	Gold, base-metal sulfides, quartz	3X background
Rosamond prospect	25	10N.	13E.	Fracture coatings, disseminated	Tuffs, breccia sediments of Tertiary age	Autunite, gummite?	Mn and Fe oxides	0.002 U-0.59U
Section 10 Anomaly, Mojave Mining District	10	9N.	13W.	Fracture coatings, disseminated	Latite and granodiorite	Autunite	--------	Approx. 0.2 U
Silver Lady claims	10	30S.	36E.	Fracture coatings, disseminated	Granite of Jurassic(?) age and volcanics of Pliocene (?) age	Metatorbernite	Molybdenum minerals, Fe and Mn oxides, garnet, quartz	0.071 U_3O_8 31.10 U_3O_8 (select)
Silver Strand claim	10	25S.	32E.	Fracture coatings	Marble	Radium or radon gas decay products(?)	--------	--------
Stillwell property	35	10N.	13W.	Fracture coatings, disseminated	Litbic tuffs of Tertiary age	Autunite	--------	0.012 U-0.14U
Sun Dog claim	9	28S.	32E.	Accessory mineral(s) in pegmatite	Pegmatite	--------	Pyrite, arsenopyrite	0.14 eU_3O_8, 0.105 U_3O_8
Surprise No. 1 claim	3	30S.	21E.	Fracture coatings	Siltstone and shale	Secondary uranium minerals	Fe oxides	0.11 U_3O_8
Vanuray claim	26	11N.	8W.	Fracture coatings, disseminated	Sandy clay of Micene age	Carnotite	Mn and Fe oxides, opal	0.056 U
Verdi Development Co. property	36	10N.	13W.	Fracture coatings	Tuffaceous sandstone, granitic rock	Meta-autunite	--------	0.18 U_3O_8

Table 2. Radioactive occurrences in California (by counties)[a]—Continued.

Map No.[b]		Location[c]			Type	Country rock	Radioactive ineral (s)	Other minerals	Sampl (in pe
		Section	Township	Range					
18	Wattensbarger prospect	23	25S.	31E.	Accessory mineral in pegmatite	Pegmatite and aplite	--------	--------	----
					Los Angeles County				
63	Lookout Lode claim	9	8N.	8W.	Vein	Quartz monzonite, aplite dikes	--------	Chalcopyrite, secondary Cu minerals, quartz	0.02 U_3
66	Rafferty property	26	7N.	8W.	Disseminated	Granite, aplite dikes	Autunite	Hydrotbermal clay, quartz	0.2 U_3O
					Madera County				
11	Rainbow claim	?	4S.	24E.	Vein	Granodiorite of Jurassic (?) age	--------	Quartz, chalcopyrite, tetrahedrite, bornite, pyrite	0.003 U
					Mono County				
10	Relicb prospect	?	5N.	27E.	Disseminated?	Rbyolitic tuff	--------	--------	5X back
12	Wild Bill group	18	3S.	31E.	Vein	Quartz monzonite	--------	Gold, tenorite, cerussite, chalcopyrite, iron oxides, clay, quartz	0.37 U_3
					Nevada County				
7	Truckee Canyon group	13	18N.	17E.	Vein	Granodiorite and granitized sediments	Primary(?) uranium mineral(s), metazeunerite	Pyrite, chalcopyrite, malachite	0.50 U_3
					Plumas County				
4	Brown property	36(?)	23N.(?)	16E.(?)	Pegmatite access. mineral	Pegmatite	--------	--------	35X bacl
3	Guidice mine	25	24N.	16E.	Vein	Granitic rock	--------	Cbrysocolla, malachite, molybdenite, scbeelite	5X back
2	Perry Jones claims	13 18	24N. 24N.	16E. 17E	Vein	Granodiorite	Torbernite, metazeunerite (?)	Cbrysocolla, malachite, iron oxides	0.094 U·
1	Stokes property	24	25N.	8E.	Disseminated	Hot springs deposits in metasedimentary rocks of Mississippian age	Radium mineral(s)	Fe and Mn oxides	0.66 eU, 0.001
1	Stowell property	24	25N.	8E.	Disseminated				
					Riverside County				
87	Aurora No. 1 mine	26	6S.	14E.	Vein	Granite	--------	Quartz, Cu minerals	10X bacl
88	Crescent mine claim	36(?)	6S.	14E.	Fracture coating(?)	Granite and gneissic granite	--------	Fe and Mn oxides	0.094 eU
85	Desert View claim	31, 32	5S.	10E.	Disseminated	Biotite gneiss	Monazite (?)	--------	0.15 eU, 0.005
86	Granite mine	1	6S.	15E.	Fracture	Granite	--------	Cu, Fe, and Mn minerals	10X bacl
84	Live Oak Tank area	?	2S.	9E.	Disseminated	Granite, gneiss, gabbro-diorite metasedi-ments	Monazite and Xenotime	Titanite, zircon, biotite	0.035 eU
83	Uranus claims	6	2S.	10E.	Disseminated	Granite gneiss, gabbro-diorite, quartz-biotite scbist	Allanite (?) and monazite (?)	--------	0.005 U, 0.015

Table 2. Radioactive occurrences in California (by counties)[a]—Continued.

	Location[c]			Type	Country rock	Radioactive mineral (s)	Other minerals	Sample data (in percent)
	Section	Township	Range					
San Bernardino County								
Alpha claims	9, 10, 11, 14, 15	2N.	4E.	Disseminated	Biotite-granite, metamorphic rocks	--------	--------	0.12 U
Alpha, Beta, Gamma claims	?	28S.	41E.	Fracture coatings (?)	Felsic intrusive	--------	Pyrite, secondary Cu minerals, Fe oxides, gypsum	3X background
Baxter property	18	8N.	7W.	Fracture coatings	Altered granite	--------	Clay, caliche	3X background
Coon claims	23(?)	11N.	2W.	Disseminated	Calcareous and phosphatic (?) sandstone and limestone, Barstow fm. (Miocene)	--------	Ca phosphate (bone material)	0.016 eU, 0.013 U (calcareous sandstone) 0.30 eU, 0.28 U (Fossil bone)
Copper Mountain claim	19	1N.	8W.	Fracture coating, disseminated	Diorite, gneiss, fine-grained granite	Urano-thorite(?), thorite(?), allanite	Quartz, hematite, magnetite chlorite, magnetite muscovite	0.28 eU_3O_8, 0.13 U_3O_8 0.30 ThO_2 (Select)
Fiend claim	15	9N.	6W.	Fracture coatings	Sandy limestone	Carnotite	Fe oxides	0.035 U_3O_8
Harvard Hills	?	10N.	3E.	Fracture coatings	Miocene tuffaceous sandstone, marly sandstone, limestone, chert	Autunite, carnotite (?)	--------	0.085 U
Hoerner-Ross pegmatite	15	9N.	6E.	Pegmatite	Quartz monzonite	Cyrtolite, betafite	Orthoclase, biotite, magnetite, quartz	--------
Homestretch group	19, 30	1N.	8E.	Disseminated	Granodiorite (locally gneissoid)	Monazite (?), allanite (?)	Biotite	0.005 U_3O_8, 0.33 ThO_2
Jeep No. 2 claim	10	17N.	12E.	Fracture coating	Quartzite, phyllite	Carnotite	Fe, Mn, Cu, oxides, jasper, chert, cobalt bloom	0.41 eU
Kramer Hills	13, 14	9N.	6W.	Fracture coatings	Miocene tuff, marl beds, limestone	Carnotite	Clay	0.003 U
Lucky Belle group	17, 18, 19, 20	15N.	10E.	Veins	Granitic rock	--------	Chalcopyrite, pyrite, Fe oxide	0.019 U_3O_8
Lucky Seven claim	18	2N.	4E.	Disseminated, fracture coatings	Granite	Allanite (?) monazite (?)	Biotite	0.08 eU
Mohawk mine group	7, 8, 17	16N.	13E.	Vein	Quartz monzonite	--------	Quartz	5X background
Mountain Pass area including Birthday claim, Easter Sunday group, and other properties	----	16N. 15½N.	13E. 14E.	Vein, disseminated	Pre-Cambrian gneiss, shonkinite, barite-carbonate rock, andesite	Thorite, monazite	Calcite, barite, ankerite, limonite, quartz, bastnaesite, parasite	5.50 ThO_2 0.32 U
Original and Pack Saddle claims[d]	?	6N.	13E.	Disseminated	Granitic rocks, metasedimentary rocks	Monazite (?)	--------	0.005 U, 0.06 Th
Paymaster mine	8	13N.	10E.	Vein	Pre-Cambrian limestone	Secondary uranium minerals	Clay, quartz	0.04 U_3O_8
Rainbow group	?	13N.	10E.	Pegmatite	Granitic rocks	Monazite, thorite, hyalite opal	Quartz, feldspar, magnetite, hematite	0.027 U

Table 2. Radioactive occurrences in California (by counties)[a]—Continued.

Map No.[b]		Location[c]			Type	Country rock	Radioactive mineral (s)	Other minerals	Samp (in p
		Section	Township	Range					
70	Red Devil claim	?	6N.	18E.	Vein	Granite of Jurassic (?) age	--------	Quartz, stibnite, cinnabar, stibiconite	0.084 U
78, 79	Rock Corral area including Jenkins, Conkey, Black Dob claims, and and Pomona tile quarry	----	3N. 2N.	4E. 5E.	Disseminated, placer	Quartz monzonite, biotite-rich inclusions of Jurassic (?) age	Allanite, zircon, samarskite, monazite, euxenite	--------	0.15 eU
65	Roll property	18	8N.	7W.	Disseminated	Biotite granite	Allanite	Biotite	0.72 eU 0.02(
74	St. Patrick group	7, 8	1S.	1E.	Disseminated	Schist	Pitchblende (?)	Feldspar, quartz	45X ba
80	Steiner claims	31	2N.	7E.	Disseminated	Biotite schist	Monazite (?) allanite (?)	Biotite	0.055 e
72	Thum Bum claim	28	2N.	2E.	Disseminated	Granite of Jurassic (?) age pre-Cambrian schist, diabase dike	Primary (?) uranium mineral (s)	Magnetite, feldspar, quartz, biotite	0.2 U
60	Yellow Tiger claim	25	10N.	6W.	Fracture coatings	Tuff of Miocene age	Secondary uranium minerals	--------	0.025 U
73	Yerih group (Scotty Wilson property)	3, 4	2N.	1E.	Replacement	Limestone of Paleozoic age	Pitchblende?	Pyrite, pyrrhotite, chalcopyrite, galena, sphalerite	0.37 eU
76	Zabdiel Mining Co. property	8, 16	2N.	4E.	Disseminated	Pre-Cambrian schist and gneiss, pegmatite, aplite	--------	Biotite	0.116 U
	Unnamed[d]	14	11N.	7W.	Fracture coatings	Sandy clay of Miocene age	Carnotite	--------	----
					Tuolumne County				
9	Gen. U. S. Grant mine	?	3N.	15E.	Radon gas	Slate, schist of of Paleozoic age	--------	Gold, quartz, iron oxides	5X back
					Ventura County				
71	Grimes Canyon area	7, 18	3N.	19W.	Disseminated ?	Sedimentary rocks, interstratified and intrusive (?) volcanic rocks of Tertiary age	--------	--------	3X back

[a] List does not include the 85, or more, thorium- or uranium-bearing placer deposits examined by personnel of the Union Mines Development Corporation, U. S. Bureau of Min Atomic Energy Commission, and U. S. Geological Survey or placer occurrences listed in Murdock and Webb (1948).
[b] Numbers correspond with those used on map (fig. 1).
[c] All township and range locations are based either on the Mount Diablo meridian or the San Bernardino meridian.
[d] Not shown on map (fig. 1).
[e] Proj.—projected.

consists of an extensive interior region of mountain ranges separated by broad, alluvial-filled desert valleys. The Mojave Desert is separated from the Sierra Nevada province and the Basin and Range province on the north by the Garlock fault, and from the Transverse Ranges province on the southeast by the San Andreas fault. The eastern boundary of the Mojave Desert province lies outside of California; only the part within California is covered by this report.

The dominant bedrock types in the region consist of crystalline, metamorphic rocks of Paleozoic age and older Paleozoic sedimentary rocks, some early Mesozoic sedimentary rocks, intrusive plutonic rocks and related pegmatites of pre-Tertiary age, and Tertiary continenta volcanic rocks.

Concentrations of radioactive materials in the M Desert are associated with foliated, pre-Cambrian rocks, such as those at Mountain Pass and in the Oak Tank area. They are found in pegmatites and tonic granitic rocks, such as those, for example, at Corral, the Pomona Tile quarry, Lookout Lode and elsewhere. In addition, they are associated with tiary rocks at many localities. The Tertiary rocks, sisting largely of continental lake beds and vol flows, breccias, and tuffs, are the host for most o occurrences of secondary uranium minerals.

*Rosamond Prospect (53).** Small quantities of tuite and gummite (?) occur in tuffaceous sedimen- rocks at the Rosamond prospect in the SW¼ sec. . 10 N., R. 13 W., San Bernardino base and merid- n. The property is about 10 miles south of Mojave, er County. In 1950, when the property was examined r he Atomic Energy Commission by F. M. Chace of e . S. Geological Survey, it was owned by the South- n Pacific Railroad; and in 1952, when examined by ore W. Walker and Luther H. Baumgardner, it was id· lease to Mr. Clifford Gillespie of Hollywood, Cali- rn. Workings made in 1952 consisted of a short adit, 2(oot shaft and shallow pits. Nine holes were drilled tven September 12, 1953 and November 18, 1953 to st uffaceous beds west of the adit portal. Of the nine le three were financed by the lessee and the remain- g ix were financed, in part, by a DMEA loan. None te cores from the drill holes showed sufficient radio- ti ty to justify assays for uranium content.

Rcks exposed in the vicinity of the Rosamond pros- ethave been mapped by Simpson (1934) as part of s Rosamond formation of Miocene age. The basal ram of the Rosamond formation, as exposed near the ose ect, is a dark, highly brecciated amygdaloidal flow- cbof andesitic or basaltic composition. The overlaying dsof tuffaceous rocks strike northwest and dip at low gs to the southwest. Several steeply dipping faults te vicinity of the adit portal have a northwest to ss strike and displace the tuffaceous beds as much as fet.

Uanium minerals are erratically and sparsely dis- ibted over an area of about 15 acres. Autunite occurs iipally as thin coatings on fracture surfaces; in acs, it is disseminated in the tuffaceous rocks adjacent faults and fractures. Locally, on slickensided fault rfces, there are small quantities of a brittle and waxy r reddish-brown to black radioactive mineral tenta- re identified as gummite. Assays of 12 samples of the tuite- and gummite (?)-bearing material indicate u nium content ranging from 0.002 to 0.59 percent dan average of slightly less than 0.08 percent ura- n.

Verdi Development Company Property (54). Occur- ncs of meta-autunite coating fractures in granodiorite e present on land leased by the Verdi Develop- er Company of Hollywood, California. One such oc- rnce on ground formerly referred to as the "School e on property" is about 300 yards west of the Mo- veTropico Mine road and 2½ miles north of the Trop- ine in sec. 36, T. 10 N., R. 13 E., Kern County. i occurrence is on a small knoll of granitic rock p ated from tuff and sandstone of the Rosamond rmation (Simpson, 1934) by a fault. Nearly parallel rtal fractures in the granitic rock strike northwest. et-autunite coats many of these fracture surfaces.

Anormally high radioactivity measured with a scin- lation counter ranged from 0.1 MR/hr to 2.0 MR/hr daveraged about 0.3 MR/hr over an area 30 feet by 0 feet. Background count over barren rock averaged o 0.03 MR/hr. Development of the property consists merous jackhammer holes and several wagon drill le trenches and shallow cuts. Samples collected from e property by the U. S. Atomic Energy Commission indicated a uranium content as high as 0.18 percent U_3O_8.

Section 10 Anomaly, Mojave Mining District (55). Abnormally high radioactivity was discovered by the U. S. Atomic Energy Commission during an aerial survey in the Mojave mining district, Kern County. The location of the anomaly was shown on a map published by the Commission in the spring of 1954. A ground check of the anomaly by private individuals resulted in the discovery of a deposit of autunite. During the summer of 1954, Mr. Robert P. Donovan sank a 30-foot inclined shaft at the site of discovery and stockpiled several tons of uranium-bearing rock.

Bedrock in the vicinity of the anomaly consists of a brownish-gray andesite porphyry dike in quartz monzonite of Jurassic(?) age. The dike strikes east and dips steeply south. It is as much as 100 feet thick and is exposed along strike for approximately 2,000 feet.

Autunite is exposed in the shaft and at the surface near the shaft collar. It coats fracture surfaces in the dike rock and in the quartz monzonite adjacent to the dike.

A grab sample of autunite-bearing dike rock, collected 10 inches below the surface by the Atomic Energy Commission, assayed 0.41 percent U_3O_8.

Jumpin Claim (56). The Jumpin claim, in secs. 9 and 10, T. 9 N., R. 13 W., is 5.5 miles west-northwest of Rosamond, Kern County. In November 1951, the property was owned by Sam Cytron of Beverly Hills, California. Development consisted of a 25-foot trench, a 10-foot pit, and a shallow bulldozer cut.

The country rock is altered rhyolite intrusive into quartz monzonite of Cretaceous(?) age. Autunite, gummite(?), and iron oxide coat fractures in the rhyolite. Assays of chip samples of uranium-bearing rhyolite range from 0.002 to 0.037 percent and indicate an average uranium content of about 0.02 percent.

Goldenrod Claim (57). The Goldenrod claim is in sec. 4, T. 9 N., R. 13 W. about 7 miles west-northwest of Rosamond, Kern County. It had not been developed when examined in April 1952.

Tests for radioactivity of the property indicate that an undetermined radioactive mineral is sparsely disseminated in dacite of the Rosamond formation of Simpson (1934). Locally the dacite is flow-banded, autobrecciated, and conspicuously jointed. Slight concentrations of the radioactive mineral occur with hydrated iron oxides on the surfaces of a fracture of minor displacement.

A sample of the dacite country rock contained 0.006 percent equivalent uranium * and 0.001 percent uranium; a sample of the iron-stained material contained 0.063 percent equivalent uranium and 0.041 percent uranium.

Stillwell Property (58). Autunite has been identified at the Stillwell property in sec. 35, T. 10 N., R. 13 W. about 5 miles (direct line) northwest of the town of Rosamond, Kern County. In 1952, the property was owned by Mr. L. J. Stillwell, North Hollywood, Cali-

* bers in parentheses refer to location map and table.

* "Equivalent uranium" is the amount of uranium in equilibrium with its daughter products that would produce the same amount of radioactivity that is emitted by a given sample. This value is commonly shown as "eU."

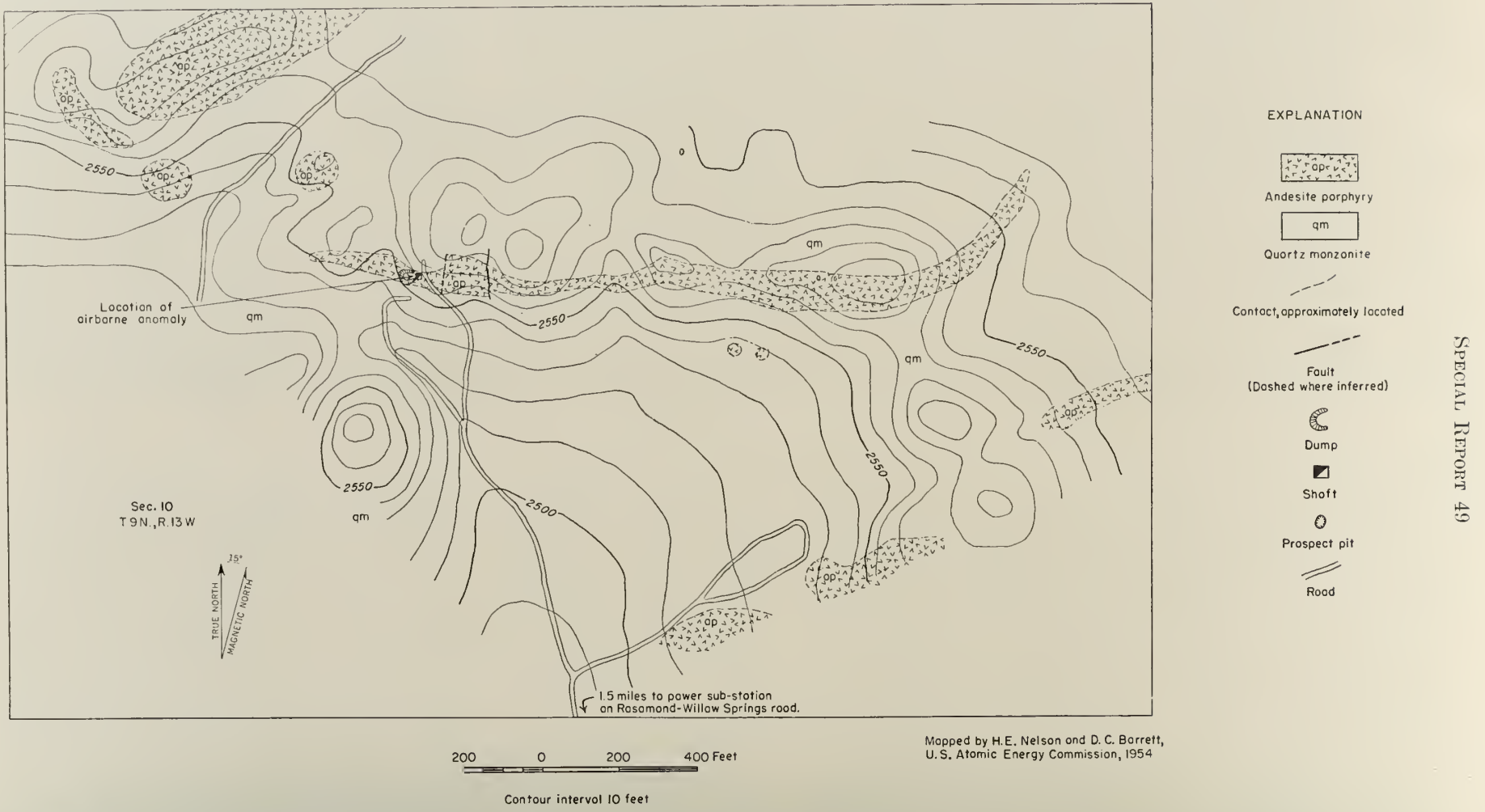

FIGURE 2. Geologic map of vicinity of Section 10 anomaly, Mojave mining district, Kern County, California.

na. Development consists of three trenches, approx-ely 2 feet wide and 15 feet long.

ne- to coarse-grained tuffaceous rocks, which were ped by Simpson (1934) as part of his Rosamond ation of Miocene age, are exposed in the area. ing in the tuffs strikes N. 40° W. and dips approx-ely 15° to the SW. Small faults, which strike N. E. and are nearly vertical, cut and offset the ing. Autunite is erratically distributed as joint and ure coatings and as disseminations in the tuffaceous in and adjacent to some of the faults. An assay lect chips collected from a mineralized fault indi-a uranium content of 0.14 percent, whereas assays 2-foot continuous channel sample across the fault ate a uranium content of 0.09 percent.

Middle Butte Mine (51). The Middle Butte mine is d by Mrs. Mary B. Johnson of Whittier, California. about 8 miles southwest of Mojave, California in .6, T. 10 N., R. 13 W., Kern County. The workings st of approximately 5,000 feet of shafts, drifts and cuts from which over $150,000 in gold was mined. ock exposed in the workings consists of altered ite porphyry and tuff, part of which is kaolinized. gold-bearing veins strike N. 26° W. and dip 35° E.

radiation intensity of 0.15 MR/hr was noted in the ings on the adit level where autunite sparsely coats ure surfaces in the kaolinized rhyolite porphyry. ings as high as 1.5 MR/hr are present in a crosscut the bottom of the Ella shaft, 700 feet west of the portal; samples collected from the point of highest ng were not anomalously radioactive when removed the mine, and no secondary uranium minerals were ile. Radon gas is believed to be the source of much e highest radioactivity in the parts of the mine e little air circulates. A select sample of autunite-ng rock contained 0.025 percent uranium.

Table 3. Sampling data, Middle Butte mine, Kern County, California.

Sample number	Description and locality	eU (percent)	U (percent)
S-54--	Continuous 6-foot chip sample in NE drift of 201 tunnel. Consists of partially kaolinized rhyolite porphyry and tuff	0.004	--
S-54--	Select sample from middle of above continuous chip sample (HGS-1-54)	0.012	0.025
S-54--	Grab sample of unmineralized, partially kaolinized, rhyolite porphyry and tuff from face of NE drift, 201 tunnel	0.002	--
S-54--	Grab sample of altered rhyolite tuff with iron-oxide stain, 20 feet from face of drift, second level, Ella shaft	0.002	--
S-54--	Grab sample of altered rhyolite porphyry and tuff from face of east drift off bottom level Ella shaft (Radiation intensity of 1.5 MR/hr was measured at collection site)	0.001	--

luett Property (50). Radioactivity amounting to mes background count was detected by geologists e U. S. Atomic Energy Commission at the property Ir. Walter Bluett of Bakersfield, California. The erty is in the NE¼ of sec. 9, T. 10 N., R. 13 W., e County. The workings consist of a shaft 20 feet . Bedrock exposed in the area consists of tuffaceous rocks of the Rosamond formation of Simpson (1934) of Miocene age, and quartz monzonite of Cretaceous(?) age. Maximum radioactivity in the area is along an east-trending fault. Autunite associated with iron oxides was seen in the shaft.

Mamie Claim (52). The Mamie claim, owned by Mr. John Lodge of Altadena, California and leased to Mr. Harry E. Kuhfus of Los Angeles, is on the southwest side of Soledad Mountain in sec. 18, T. 10 N., R. 12 W., Kern County.

Anomalous radioactivity amounting to 12 times background count was measured along a shear zone in rhyolite. The shear zone strikes N. 32° W. and dips 70° NE. Radiation intensity of the rhyolite wall rock is approximately 3 times background count.

Buster Tom Claims (48). The Buster Tom claims are in sec. 8, T. 11 N., R. 14 W. in the Tehachapi Mountains, about 6 miles south-southeast of Tehachapi, Kern County. They are owned by Messrs. Chris A. Chroman and Thomas N. Pratt, Delano, California. Bedrock exposed in the vicinity consists of granitic rock of Cretaceous(?) age. Autunite and gummite (?), associated with iron and manganese oxides, smoky quartz, and clay occur along a fault that strikes S. 58° E. and dips 80° SW. Radiation intensity along the fault is as high as 0.12 MR/hr; background count is 0.025 MR/hr.

Emerald Queen Claims (49). The Emerald Queen group of 22 claims are in the Tehachapi foothills ½ mile south of US Highway No. 466, 5 miles northwest of Mojave, California. They include the site of a radioactivity anomaly detected by airborne instruments of the U. S. Atomic Energy Commission. The claims are owned by Messrs. S. J. Westberg and R. G. Westberg of Mojave. Bedrock exposed in the area includes tuffaceous and calcareous sandstone of the Rosamond formation of Simpson (1934). Faults, possibly branches of the Garlock fault, are present in the area. Channel samples of tuffaceous sandstone from the claims collected by geologists of the Atomic Energy Commission assayed as high as 0.054 percent U_3O_8. No uranium minerals were identified at the time of examination.

Josie Bishop Group (32). The Josie Bishop group of claims, owned by Josie Bishop, is in sec. 30, T. 29 S., R. 37 E., 4 miles west of Ricardo and approximately 25 miles north of Mojave. The group consists of 12 contiguous claims. Workings in 1948 included an 80-foot discovery shaft, drifts, and several open cuts.

Table 4. Sampling data, Bishop claims, Kern County, California.

Sample number	Description and locality	eU (percent)	U (percent)
RUK-1-48--	5-foot chip sample across fracture zone. Discovery shaft (Badger) of Beryl No. 6 claim	0.004	0.003
RUK-2-48--	26-foot chip sample around discovery shaft on Beryl No. 4 claim	0.005	0.003
RUK-3-48--	6-foot chip sample around face and walls of open cut at discovery end of Beryl No. 11 claim	0.002	0.001
RUK-4-48--	6-foot chip sample around face and wall of open cut	0.005	0.003
RUK-5-48--	Grab sample of unmineralized granite from Bishop claims	0.004	0.002

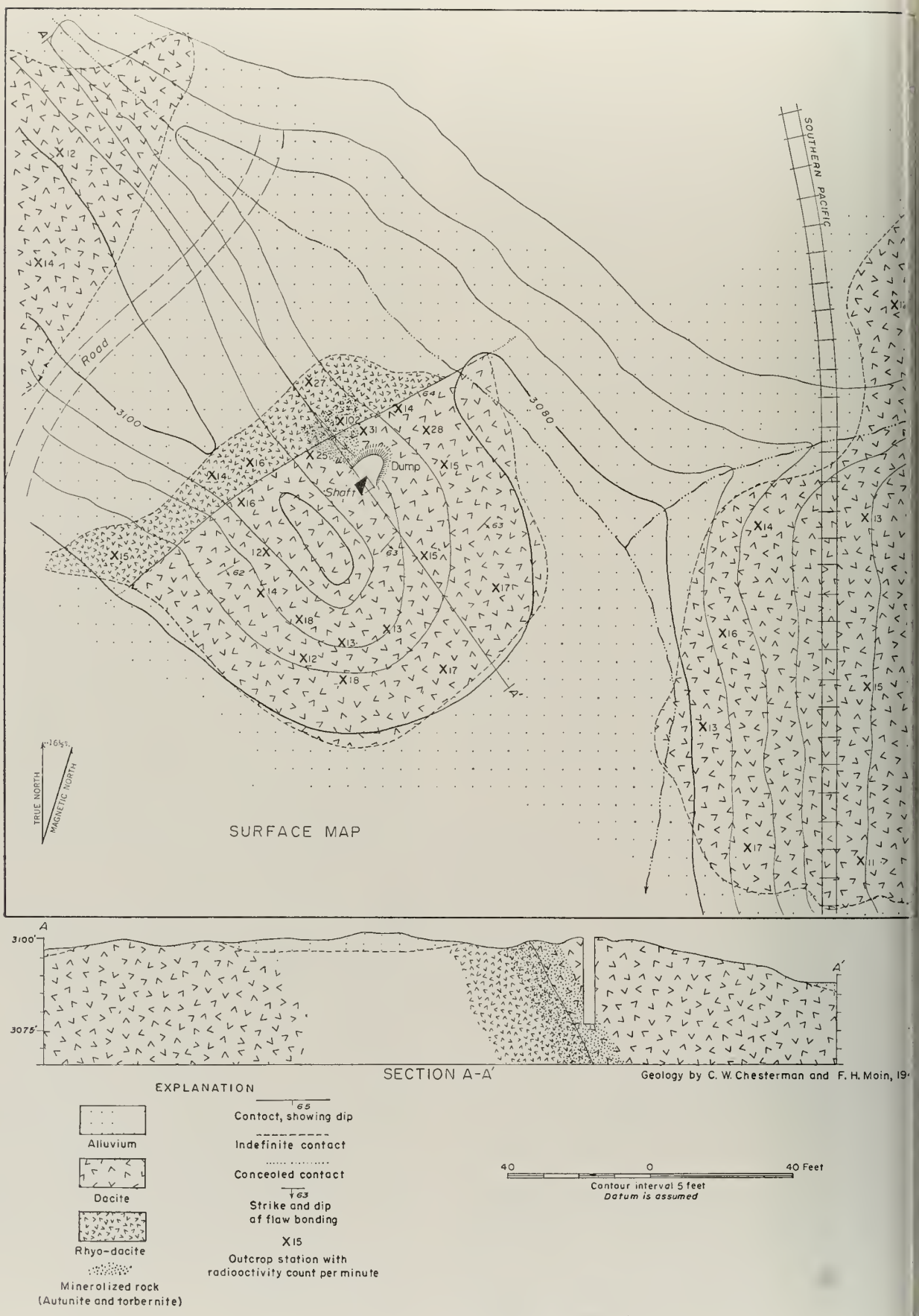

FIGURE 3. Chilson prospect, Kern County, California.

rock exposed in the vicinity consists of pink granruded by alaskite dikes.

most highly radioactive sample collected from the lags contained 0.003 percent uranium.

demacher Claim (29). The Rademacher claim is in T. 28 S., R. 40 E., Mt. Diablo meridian, 12½ miles of the town of Johannesburg in the Johannesburg ig district. It is owned by Mr. Joseph Forse of nesburg. The property, which was located for gold 6, has been developed by a 200-foot vertical shaft several hundred feet of inter-connected workings. ine has yielded over $120,000 in gold.

urtz fissure veins and shear zones containing base-ta sulfides, secondary base-metal minerals, and free dare in granitic rock of probable Jurassic age. Tore, associated with iron and manganese oxides, u in the shear zones.

ilson Property (30). A small body of mediumid rhyo-dacite and dacite, associated with Red utain andesite, is in the Summit Range 6 miles north Rudsburg, Kern County, in sec. 36 (?), T. 28 S., R. E Mt. Diablo meridian. Torbernite and autunite are n as small green and yellow foliated crystals on n surfaces and in small cavities in the dacite. The nium-bearing minerals have been concentrated by ud water circulating along the contact between rhyoi and dacite. The deposit had been prospected by pen cuts, and a shaft about 25 feet deep, when ned by C. W. Chesterman and F. H. Main in 1946. e Chilson property, known also, at various times as onsen property, Summit Diggin's, Uranous claim, Ernes' property, was under lease to Mr. Philip J. rs of Los Angeles in December 1951.

A hip sample from the face of one open cut in the nalized zone assayed 0.121 percent equivalent ura- Geiger counter readings on outcrops of the unmindacite indicate no more than about 0.002 per- quivalent uranium.

able 5. Sampling data, Kramer Hills, San Bernardino County, California.

ame mber	Description and locality	eU (percent)	U (percent)
-8 0	12-foot channel sample of clay, dolomite, including zone sampled by No. 261; from trench in Barstow formation	0.002	0.002
1	3-foot channel sample of clay, dolomite, marl, yellow-stained; from trench in Barstow formation	0.004	0.003
2	Grab sample, greenish-yellow-stained, thick-bedded, dolomitic marl, from portal trench in Barstow formation	0.000	0.001
3	Grab sample, marly clay, stained greenish-yellow; from shaft about 700 feet northwest of trench	0.001	0.001
H	Grab sample, shale from trench in Barstow formation; smear of yellow secondary uranium minerals on bedding planes	0.064	0.11
I-	Grab sample, from 5-inch dolomite bed in trench in Barstow formation	0.006	0.006
I-	Grab sample, 12-inch shale zone in trench in Barstow formation	0.012	0.016
I-	Grab sample, 12-inch shale zone in trench in Barstow formation	0.008	0.008
I-	Grab sample, 12-inch shale zone in trench in Barstow formation	0.004	0.003

DFH-1 to DFH-5, incl., collected by D. F. Hewett from SW¼ sec. 15, T. 9 N., R. 6 W. Collection site is a trench 50 ft. long and 10 ft. deep.

Vanuray Claim (59). The Vanuray claim is in sec. 26, T. 11 N., R. 8 W., about 2½ miles northwest of Boron, Kern County. In November 1951, it was owned by Mr. C. J. Roycroft of Boron. Prior to the discovery of uranium on the property, an 18-foot pit about 100 feet in diameter was excavated, presumably to exploit clay deposits on the property.

The uranium is in sandy clay which probably is a part of either the Ricardo formation or the Rosamond formation (Gale, 1946) of late Tertiary age. Bedding in the clay strikes N. 30° E. and dips approximately 40° NW. A few, indistinct, minor shear zones in the clay are as much as 1.5 feet in width. They strike about N. 70° W. and dip steeply. Carnotite occurs with opal and minor amounts of iron and manganese oxides as fracture coatings in the shear zones and as sparse disseminations in the sandy clay in and adjacent to the shear zones.

A selected grab sample, taken where the radioactivity is highest, assayed 0.056 percent uranium. A composite of chip samples taken from a 12-foot zone that included 1.5 feet of a weakly mineralized shear zone assayed 0.018. A grab sample of wall rock assayed 0.005 percent uranium.

Kramer Hills (61). In 1947, D. F. Hewett, U. S. Geological Survey, discovered yellow stains in prospects in the Kramer Hills in secs. 12 and 14, T. 9 N., R. 6 W., San Bernardino meridian, which he tentatively identified as carnotite. Following positive identification of the yellow stain as carnotite, the prospects were examined in January 1949 by D. G. Wyant of the Geological Survey and D. F. Hewett. Claims covering the property are owned by O. H. Ball, Los Angeles. At the time of the examination in 1949, workings on the claims consisted of a trench approximately 100 feet long, two shallow shafts, and several prospect pits.

The Kramer Hills area consists of a pre-Cambrian basement complex overlain by marine Paleozoic sedimentary rocks that are intricately folded, faulted, and intruded by granitic rocks of Jurassic(?) age. The basement and Paleozoic rocks are overlain by a thick sequence of non-marine Cenozoic sedimentary and interbedded volcanic rocks. The uranium deposits occur in the Barstow formation of Miocene age which consists, in this area, of a sequence of pale green volcanic ash beds and interbedded white or buff clay and marly clay beds that are, in part, dolomitic. A basalt flow rests unconformably on the ash and clay beds. Locally, on joints and bedding surfaces exposed in the prospect pits, the marly clay beds are stained red, greenish-yellow, and canary yellow; some of the yellow stain is composed of minute particles of carnotite and some of the greenish-yellow stain has been identified as hydro-muscovite.

Readings taken at 13 localities with a Geiger counter indicate anomalous radioactivity only slightly above background readings.

Yellow Tiger Claim (60). The Yellow Tiger claim is on the north flank of the Kramer Hills in sec. 25, T. 10 N., R. 6 W., Kern County. It is owned by G. V. Anderson and M. I. Shelton, and is leased to W. L. Durham and L. Wachter, all of Colton, California. Workings on the property in February 1954 consisted of three bulldozer trenches, each about 50 feet long. Yellow secondary uranium minerals stain fracture surfaces in volcanic tuff of the Barstow formation of Miocene age. Radio-

activity measured by the U. S. Atomic Energy Commission is slightly over three times background; a select sample from the site of highest measurement assayed 0.025 percent U_3O_8.

Fiend Claim (62). The Fiend claim is on the south end of the Kramer Hills in sec. 15, T. 9 N., R. 6 W., Kern County. It is owned by D. B. McGee and A. R. Kleinkauf, Houston, Texas. Carnotite occurs with iron oxide in thin-bedded sandy limestones of the Barstow formation of Miocene age. The workings consist of several prospect pits. Maximum radioactivity on the claim is 10 times background count. Chip samples taken over 2-foot intervals by the U. S. Atomic Energy Commission assayed as high as 0.035 percent U_3O_8.

Lookout Lode Claim (63). The Lookout Lode claim is in the northeast corner of sec. 9, T. 8 N., R. 8 W., San Bernardino meridian, about 25 miles northeast of Lancaster, Los Angeles County. In March 1952, it was owned by S. J. Curtis and Earl Hollingsworth of Lancaster. At that time, development consisted of 2 small pits about 100 yards south of an abandoned gold mine.

The pits expose about 6 feet (strike-length) of a mineralized shear zone in quartz monzonite, aplite, and pegmatite of Cretaceous(?) age. The shear zone is a maximum of 1.5 feet in width. It strikes N. 40° E. and is nearly vertical. Abundant quartz, lesser amounts of chalcopyrite, pyrite, tenorite, azurite, hydrated iron oxides, manganese stain, and minute quantities of an unidentified black uranium mineral are in the shear zone.

Samples of mineralized rock taken from the shear zone by Mr. S. J. Curtis and analyzed by the U. S. Atomic Energy Commission contained slightly less than 0.02 percent equivalent uranium. Testing of the dump for radioactivity at the abandoned gold mine indicates gamma ray activity the same as, or only slightly above, the background count.

Baxter Property (64). The Baxter property is in the Silver Mountain district a few miles southwest of the Kramer Hills. The deposit, which in 1950 was owned by Mr. N. Baxter of Hemet, California, is in sec. 18, T. 8 N., R. 7 W., San Bernardino meridian. He explored the deposit by a bulldozer trench 50 yards long. The country rock is altered granite which is cut by a network of veins containing clay and caliche. Radioactivity of some of the vein material is about 3 times background count, although no uranium minerals are visible.

Roll Property (65). The Roll property consists of 24 placer claims in sec. 18, T. 8 N., R. 7 W., San Bernardino County. It is owned by Michael J. Roll of Anaheim, California, and Ray Heatherington of Buena Park, California.

The claims cover level valley fill about 10 feet thick. Rounded hills of biotite granite are nearby. Workings on each of three claims consist of bulldozer trenches and a shaft 10 ft. deep. The shafts expose the biotite granite beneath the valley fill. Abnormally high radioactivity appears to be confined to approximately 3 feet of granitic detritus that is under about 2 feet of soil. Eighteen inches of the radioactive zone that was sampled by the U. S. Atomic Energy Commission was found to contain 0.03 percent U_3O_8. One sample submitted to the U. S. Geological Survey by Mr. Roll contained 0.72 percent equivalent uranium and 0.026 percent uranium; the radioactivity of the sample was caused by th bearing allanite.

Rafferty Property (66). The Rafferty propert the Willsona mining district in sec. 26, T. 7 N., R San Bernardino meridian, about 25 miles east c caster, Los Angeles County. In 1950, the depo owned by John and Mike Rafferty of Adelant fornia. The property has been developed sporadic hand labor since its discovery in 1948.

Exposures at the deposit consist of deeply we granite in which aplite dikes and quartz veinlets companied by zones of hydrothermal alteration. A and other secondary uranium minerals occur wi minerals as late fracture coatings in hydrotherma Chip samples taken from the zones contained as n 0.2 percent U_3O_8.

Coon Claims (67). The Coon claims are in (?), T. 11 N., R. 2 W., about 9 miles north-north Barstow, San Bernardino County. The owner i Coon of Burbank, California.

Anomalous radioactivity, amounting to a maxi 0.5 MR/hr is present in calcareous and tuffaceo ments of the Barstow formation of Miocene ag beds strike northwest and dip 70° N.E. Many active fossil bone fragments occur in clay and sh are strongly reactive to phosphate tests. Even t careous sandstone beds show positive reaction fo phate. No uranium minerals were identified; it gested that uranium in the samples collected fr Coon claims occurs as traces in the phosphate r present in the bone material and possibly in a ph cement in the sandstone.

Table 6. Sampling data, Coon claims, San Bernardi County, California.

Sample number	Description and locality	eU (percent)	U (percent)
JCG-1	Calcium carbonate rock near dry wash	0.024	0.018
JCG-2	Calcareous sandstone near dry wash	0.016	0.013
JCG-3	Phosphatic fossil bone material near dry wash vicinity of discovery monument	0.30	0.28

Harvard Hills (68). Secondary uranium m have been found in several places in the vicinity Harvard Hills in T. 10 N., R. 3 E., San Bern meridian, about 9 miles east of Yermo. Anomalous activity has been detected both north and south o Highway 91 which, in this area, parallels the Pacific Railroad. Lode mining claims, includi North Star Nos. 1 to 5, the Moonbeam, Martha 1 Jolly Boy, cover most of the mineralized areas. I many of the claims were owned by the Harvard and Development Company of Los Angeles; some claims, however, were apparently owned by othe areas of highest uranium concentration have be plored by means of several pits as much as 12 fee

The Harvard Hills, which are in the center of a alluvial valley, are composed of thin-layered lak consisting of tuffaceous sandstone, marly sandston

, clay, and chert of the Barstow formation. Autun- d carnotite (?) occur principally as coatings on ure and bedding surfaces, particularly in parts of ction containing chert and limestone. The uranium have been introduced by the lake waters, or it may been a primary constituent of the tuffaceous debris sandstone and redistributed by circulating ground- .

series of radioactivity traverses across the Harvard l indicate that the uranium minerals are concen- l principally on the north and northwest slopes of hills. Anomalous radioactivity, however, was de- l only where shallow pits expose mineralized zones. sample assayed by the U. S. Geological Survey con- l 0.025 percent uranium; another sample, assayed e U. S. Atomic Energy Commission, contained 0.085 nt uranium.

Hoerner-Ross Pegmatite (69). The Hoerner-Ross gatite, in central San Bernardino County, is on the side of the crest of a nearly conical peak south of ain ridge of the Cady Mountains; the Cady Moun- are an isolated mountain unit approximately 5 wide in a northerly direction and 9 miles long in sterly direction. The peak is 7 miles N. 56° E. of or station on the Santa Fe Railroad. Hector station miles east of Barstow. The pegmatite is accessible desert road 3 miles east from Hector, north under lroad bridge, then 6 miles northeast up a wash to east side of the peak. It also may be reached by lling another desert road north from Hector for 2 miles, then east 4 miles to a wash, and then up wash to its end, which is another 4 miles from the west road. From the end of the wash, a steep trail, g 700 feet vertically over a horizontal distance of 2,500 feet, leads up the bare ridge to the deposit. ecord of studies or mapping exists for that part of Cady Mountains containing the Hoerner-Ross peg- te. In 1945, however, the eastern and southern parts e Cady Mountains were mapped by Cordell Durrell 3), in connection with a study of the celestite de- s along the southern slope.

Durrell's geologic map shows that the southeastern of the Cady Mountains is Tertiary volcanic rock; t flows occur at the base of the section and are lain successively by andesite flows, rhyolite tuffs, playa desposits containing beds of celestite. His also shows a small area of granite in the saddle rating the Cady Mountain mass from the hills lying he southeast. This granite was later classified as tz monzonite and will be considered as such in this r. The quartz monzonite appears to form the higher of the Cady Mountains in which the pegmatite oc- It is pale reddish-brown, where fresh, and is sely crystalline. Crystals of feldspar in the quartz zonite range in size from $\frac{1}{8}$ to $\frac{3}{8}$ of an inch in di- er; grains of quartz and biotite are smaller. Thin ons show that the rock is composed of orthoclase and rocline, 35 percent; quartz, 30 percent; plagioclase desine), 25 percent; microperthite, 5 percent; and te, 3 percent. The monzonite shows several systems ints, but lacks the layering or foliation common in re-Cambrian rocks of this region.

Numerous dikes of a rock similar in composition to the tz monzonite, though of a finer grain size, occur in the vicinity of the Hoerner-Ross pegmatite. A thin section of the dike rock shows quartz 35 percent; orthoclase and microcline, 30 percent; plagioclase (andesine) and microperthite, 25 percent; magnetite, 5 percent; biotite, 3 percent; and sphene, 2 percent. The dikes trend northwest roughly parallel to the pegmatite. The pegmatite body strikes about N. 10° W. and dips 65° W. It is about 100 feet long and 25 feet wide at the widest part, and is roughly elliptical in shape. The contact between the pegmatite and the enclosing quartz monzonite is sharp. The owners report two other small bodies of similar pegmatite nearby.

The pegmatite, as exposed in an open cut 40 feet long and 10 feet deep, is roughly separable into two layers. The lower (eastern) layer is about 12 feet thick, faintly layered, and is made up largely of feldspar, with minor amounts of magnetite, quartz, green mica and other minerals. The predominant mineral, flesh-colored coarsely crystalline feldspar, in places has cleavage faces several inches in diameter. Locally, it has been replaced by feathery white albite. Magnetite occurs in the flesh-colored feldspar as small isolated masses as much as 2 inches long. Quartz, in the lower layer, occurs as small pipe-like bodies several inches in diameter and 6 to 15 inches long. The longer axis of these bodies is normal to the foot-wall of the pegmatite. Within the lower layer are several rounded pale yellow to green masses of an incoherent material. One of these is several inches in diameter and 10 inches long. The rounded masses are composed largely of coarse fragments of feldspar and lesser amounts of green mica, small quartz crystals, and minute tetragonal crystals of strueverite. This mineral assemblage is slightly radioactive. Rosettes of biotite plates, as much as 20 inches in diameter, were found in the lower layer. Thin plates of biotite, 5 to 8 inches long, radiate outward from centers. The rosettes contain sparse crystals of highly radioactive cyrtolite, some of which are clearly tetragonal, while others appear hexagonal in cross section.

The upper layer of the pegmatite also is about 12 feet thick. It contains large masses of white quartz which have apparently replaced parts of the original feldspar. A lens, about 36 inches long and about 20 inches thick, composed of biotite, feldspar, magnetite, and cyrtolite is exposed in the residual feldspar of the upper layer. The lens contains plates of biotite $\frac{1}{16}$ to $\frac{1}{8}$ of an inch thick and as much as 6 inches in diameter, which separate flat plates of feldspar and magnetite. Small crystals of cyrtolite are found in the biotite and along the contact of the biotite and the feldspar. Small octahedrons and grains of a uranium mineral, tentatively identified as betafite, occur in the feldspar plates and in the magnetite. Laboratory tests show that the betafite (?) contains uranium, titanium, and niobium (columbium). The outer shells of the octahedrons and grains are pale yellowish-green and fine-grained; the interiors are dark green and glassy. Approximately 5 to 10 grams of the uranium mineral can be extracted from about 25 pounds of the feldspar-magnetite-biotite rock that makes up the lens.

Unless many other lenses are present in the downward extension of the pegmatite, the amount of uraniferous material present is negligible.

Paymaster Mine (40). The Paymaster mine, in the Solo district, is 10 miles S. 80° E. of Baker, in sec. 8, T. 13 N., R. 10 E., San Bernardino meridian. In 1950, the mine was owned by Mr. Joseph Ostringer of Baker. Development work consists of two shafts and an adit. The country rock is pre-Cambrian limestone that is brecciated by many fractures and faults; many of the fractures and faults are filled with vein quartz and gouge. Near the surface, yellow secondary uranium minerals occur in the brecciated limestone as fracture coatings and as impregnations in the gouge along veins. At depth, radioactive zones in the limestone are associated with the quartz veins. Assays of grab and channel samples of the radioactive material range from about 0.003 to 0.04 percent uranium.

Rainbow Group (39). The Rainbow claims are in the Solo district, about 12 miles S. 69° E. of Baker, San Bernardino County. They were owned by Glenn and Blanche Alexander in 1952. At that time, exploration workings consisted of a 15-foot shaft on the Rainbow No. 2 claim.

The country rock consists of foliated granitic material, presumably of pre-Cambrian age, that has been intruded by a pegmatite dike. The dike strikes N. 55° W., is vertical, and is exposed along the strike for nearly 50 feet; throughout this distance it ranges in width from 6 inches to 3 feet. Dominant minerals in the pegmatite are feldspar and quartz. Erratically distributed in the pegmatite are irregular, dark gray to black, metallic masses of hematite that are as much as 10 inches in greatest dimension. The hematite is slightly magnetic and contains small amounts of magnetite. Disseminated in the hematite are anhedral crystals of slightly altered and iron-stained monazite, euhedral and anhedral crystals of thorite, and minor amounts of unidentified minerals. Joint surfaces in the hematite and, locally, in the pegmatite are coated with hyalite opal that fluoresces a brilliant green under ultraviolet light. The opal may be uranium-bearing as suggested by the fluorescent green color; it is believed that another unidentified uranium mineral is also present.

A select sample, collected by the U. S. Geological Survey, that contained hematite, quartz, and minor amounts of monazite, thorite, and hyalite opal, assayed 0.027 percent equivalent uranium and 0.027 percent uranium. A sample submitted by the owners to the U. S. Geological Survey laboratories assayed 0.02 percent uranium.

Lucky Belle Group (38). The Lucky Belle group of 11 claims is on the southern foothills of the Shadow Mountains in parts of secs. 17, 18, 19, and 20, T. 15 N., R. 10 E., San Bernardino County. The claims are owned by Percy Priest and Vergel Fergen of Santa Monica, California, and Grant Hann of Venice, California. Slightly radioactive quartz-bearing veins occur in fractures in granitic bedrock that underlies the claims. Radiation intensity is three times background count along the parts of the veins where chalcopyrite, pyrite, and iron oxide were observed. Samples collected by the U. S. Atomic Energy Commission indicate a U_3O_8 content of at least 0.019 percent.

Jeep No. 2 Claim (34). The Jeep No. 2 claim is about 6 miles northwest of Clark Mountain Peak in sec. 10, T. 17 N., R. 12 E., San Bernardino County. It is owned by Albert Schmidt and W. R. Johns of Valley ' California, and leased to Manning Briggs and assoc Development of the property includes several hu feet of workings; the mine was worked for copp 1907.

Bedrock exposed in the area consists of dolomitic stone enclosed by quartzite, phyllite, and schist of Cambrian age. Carnotite occurs with oxidized co lead, zinc, and manganese minerals in small replace bodies and along veins in the limestone. The majo structure in the mine strikes N. 46° E., dips steep the northwest and is exposed for 280 feet.

The richest sample collected from the property b U. S. Atomic Energy Commission contained 0.41 pe equivalent uranium.

Mohawk Mine Group (35). Abnormal radioact amounts to five times background count at the Mo mine group of claims in the southern foothills of Mountain in parts of secs. 7, 8, and 17, T. 16 N., R. 1 San Bernardino County. The property is owned by hawk Mines, Inc. of Fillmore, Utah. The highest r activity on this group of claims occurs in a q stringer cutting quartz monzonite. The quartz str is near a limestone-quartz monzonite contact where zinc, and copper minerals have been found. No ura minerals have been identified.

Mountain Pass Area (36, 37). Radioactive mat in association with major concentrations of rare- minerals occur in the Mountain Pass area in the n east part of San Bernardino County about 58 southwest of Las Vegas, Nevada, via U. S. Highwa The area is of particular interest because of the pres of abundant non-radioactive bastnaesite (cerium-la num fluocarbonate) and parisite (cerium-lantha calcium fluocarbonate). These rare-earth minerals in deposit were discovered in 1948 by the detection of r active thorium-bearing minerals that occur with (Pray and Sharp, 1951). Since 1949, extensive st have been made of the rare-earth deposits and the ciated thorium minerals (Olson and others, 1954) only a brief reference to the thorium deposits wi presented here.

The rare-earth and thorium deposits of the Mour Pass area are confined to a northwest-trending bloc pre-Cambrian rocks, nearly 7 miles long and more 2 miles wide, that is bounded on the north and wes faults and on the east and south by the alluviu Ivanpah Valley. Dominant rock types within the b are hornblende and mica gneisses, biotite granite gn augen gneiss, and minor amounts of dike rocks of i to intermediate composition. Intruded into the Cambrian rocks are masses of biotite shonkinite, sye and granite; they, in turn, are cut by andesite d Also present in the pre-Cambrian block are masses veins of carbonate rock composed of many mine principally calcite, dolomite, barite, quartz, bastnae and parisite. The carbonate rocks cut the potash- intrusives as well as the pre-Cambrian rocks.

Abnormally high radioactivity, largely due to thor in thorite and monazite, has been found in many pl in the Mountain Pass area. Most of the anoma activity occurs in or adjacent to areas underlain carbonate rock, although locally the shonkinite is normally radioactive. The distribution of the rare-e

als, bastnaesite and parisite, which locally amount re than 50 percent of the carbonate rock, appar- ly has little or no effect on the distribution of nalous radioactivity, whereas the distribution of te and other oxides of iron is commonly closely at to areas of high gamma-ray activity. Most of the ctive monazite has been found as crystals scattered th largest mass of carbonate rock. Thorite, and hy- rite or thorogummite, on the other hand, are the ant radioactive minerals in areas containing oxides iron.

re than 120 samples have been collected from the tain Pass area by the U. S. Geological Survey for sis of uranium and thorium content. Samples have collected from many of the claims lying between irthday Claims on the northwest and areas south th Windy group of claims on the southeast. Analyses ate an erratic distribution of uranium and thorium th Mountain Pass area; uranium values range from 0 to 0.030 percent uranium and thorium values from 2 o 6.0 percent thorium.

Thum Bum Claim (72). The Thum Bum claim is on est branch of Arrastre Creek at an elevation of r 8,000 feet, on the northeast slope of Sugarloaf tain in sec. 28, T. 2 N., R. 2 E., San Bernardino ny. It is owned by Mr. Robert A. Mindte of Bell- e, California.

On July 14, 1954, Mr. Mindte delivered 1,300 pounds terial from this property, which registered as high 1 MR/hr and reportedly assayed 0.20 percent U_3O_8, th Vitro Uranium Company's plant in Salt Lake y. Abnormal radioactivity, as high as 50 times back- ud count, occurs along a contact between granite of sic(?) age and pre-Cambrian schist. An altered e dike nearby cuts both granite and schist. No ium minerals were observed when the U. S. Atomic e y Commission visited the property in June, 1954. e nomalous radioactivity is belived to be caused by ry uranium minerals disseminated along the radio- iv zone (1 to 4 inches thick).* Accessory minerals n the contact include magnetite, pink feldspar, az, and biotite.

Yerih Group (73)†. The Yerih group of claims, ic is also known as the Scotty Wilson mine, is in Holcomb Valley district in the San Bernardino tains near Big Bear Lake, in secs. 3 and 4, T. 2 N., 1E., San Bernardino meridian. It is owned by D. F. r of Los Angeles, California, and, in 1951, was l lease to P. J. Barnes of Los Angeles, California. e Yerih group was located in 1939 and has since ld several tons of silver-lead-zinc ore. Exploration lver-lead-zinc mineralization consisted of a 30-foot tal shaft and a nearby south-trending adit. In 1951, Barnes sank a 50-foot vertical shaft about 20 feet f the original shaft, and crosscut southward on 5-foot and 50-foot levels for distances of 20 feet 0 feet, respectively. In the spring of 1952, all of orkings were inaccessible.

The mine workings are mainly in a crushed and broken zone in massive Furnace limestone of Vaughan (1922) of Mississippian(?) age. Elsewhere on the property are exposures of quartzite, black, fine-grained, foliated metasedimentary rocks, calc-hornfels, and intrusive granitic rocks. Hydrothermal sulfides including pyrite, pyrrhotite, chalcopyrite, sphalerite, galena, and argentite occur locally as irregular masses and thin seams in the limestone. A uranium mineral, probably uraninite, is erratically distributed in masses of the sulfide minerals.

Radioactivity traverses in the vicinity of the shaft collar, and tests of the mine dumps, indicate only slightly greater than background count of gamma-ray activity. Select specimens, however, have a count as high as 50 times background as measured with a portable Geiger Counter. Samples submitted by Mr. Barnes to the U. S. Atomic Energy Commission contained as much as 0.37 percent equivalent uranium and 0.32 percent uranium, but the quanity of this material is small.

St. Patrick Group (74). The St. Patrick group of claims is in secs. 7 and 8, T. 1 S., R. 1 E., San Bernardino County. They are owned by Patrick D. Haugh and Ralph D. Claxton of San Bernardino, California, and Earl H. Gilliam, Jr., of Birmingham, Alabama.

Anomalous radioactivity as high as 45 times background count was measured along a fault in schist. Feldspar and quartz are present in the radioactive zone. No uranium minerals have been identified, although pitchblende may be present in small quantity. Workings on the property at the time of examination consisted of a 15-foot adit.

Rock Corral Area (78, 79). In 1949, prospectors discovered several small masses of rock containing thorium-bearing minerals in an area about 2 miles wide and 5 miles long in the vicinity of Rock Corral, about 53 miles east-northeast of San Bernardino. In 1952, an examination of the area by D. F. Hewett, G. W. Walker, R. M. Moxham, and L. H. Baumgardner of the U. S. Geological Survey indicated that some exposures of pegmatite, vein material, masses of biotite-rich rock in plutonic crystalline rocks, and locally, the plutonic rocks themselves, contain concentrations of radioactive minerals. Several properties, including the Jenkins, Conkey, and Black Dog claims, and the Pomona Tile quarry, cover some of the areas of highest radioactivity. At the time of the examination, excavations consisted of several pits, or shallow shafts, in the most radioactive parts of the area.

Dominant rock types exposed in the Rock Corral area are pre-Cambrian biotite gneiss, siliceous metasedimentary rock, dark interlayers of metavolcanic (?) rock, and intrusive quartz-monzonite of Mesozoic age. The metamorphic rocks are metasomatically altered, locally, and the intrusive rocks are contaminated with partly assimilated blocks of wall rock. Thorium-bearing allanite, as well as radioactive zircon and monazite, are conspicuous accessory minerals in biotite-rich inclusions (or small roof pendants) in the plutonic rocks and, locally, also in the plutonic rocks; some alluvial deposits derived from these rock types are also proportionately high in allanite, zircon, and monazite. Petrographic analysis of selected rock specimens collected in the area indicates that parts of the biotite-rich inclusions contain more than 7.0 percent of allanite and more than 1.0 percent of zircon. In

*ample of radioactive material was submitted by Mr. Mindte to the Division of Mines laboratory. The radioactivity was found to be associated with yellow, orange, and gray crystal intergrowths in magnetite. The crystals were identified as altered zircon carrying thorium and some uranium. The most altered crystals (gray color) were found to be the most radioactive. The magnetite itself is not radioactive.

†Most of this information obtained from Wright, L. A., and others. (53).

addition, specimens of the plutonic rocks contain as much as 4.5 percent of allanite and 1.5 percent of zircon. Quartz-feldspar pegmatite at the Pomona Tile quarry contains minute amounts of samarskite, euxenite, allanite, and monazite associated with biotite, either magnetite or ilmenite, and other unidentified minerals. Remnants of an allanite- and monazite-bearing vein, about 15 feet long and as much as 5 or 6 inches wide, are exposed in biotite gneiss on the Black Dog claim.

A selected specimen from the Black Dog claim, submitted by Mr. B. Bauer to the U. S. Geological Survey laboratories, contained 1.87 percent equivalent uranium, 0.25 percent uranium, and 0.61 percent thoria. Selected specimens of the biotite-rich material assayed as much as 0.15 percent thorium; however, the quantity of material of this grade is small. Several analyses of the plutonic rock indicate that in some areas the rock averages about 0.008 percent equivalent uranium; many millions of tons of material of this grade are present in the Rock Corral area.

Lucky Seven Claim (75). The Lucky Seven claim, owned by P. T. Kinney of Fullerton, California, is in sec. 18, T. 2 N., R. 4 E., San Bernardino County. The only workings on the claim consist of discovery pits.

Anomalous radioactivity, as high as 1.0 MR/hr, is attributed to the presence of thorium-bearing allanite and monazite disseminated in biotite pods in granite. Radioactivity slightly exceeding background count was noted along joints in the granite.

The richest sample from this property assayed by the U. S. Atomic Energy Commission contained 0.08 percent equivalent uranium.

Zabdiel Mining Company Claims (76). The Zabdiel Mining Company property, comprising 24 claims, is in the foothills at the east end of the Little San Bernardino Mountains in secs. 8 and 16, T. 2 N., R. 4 E., San Bernardino County. Workings on the property consist of several prospect pits.

The area is underlain by pre-Cambrian schist and gneiss cut by pegmatite and aplite dikes. No uranium minerals were seen, although radiation intensity as high as 25 times background count was noted over an area 50 feet wide and 300 feet long. A specimen of biotite schist, collected by the U. S. Atomic Energy Commission indicated a U_3O_8 content of 0.116 percent.

Alpha Claims (77). The Alpha claims, comprising 14 claims, are approximately one mile north of Saddle Rock Springs in Bear Valley in secs. 9, 10, 11, 14, and 15, T. 2 N., R. 4 E., San Bernardino County. The owners are Anthony D'Alessandro and associates of Azusa, California. Workings on the property consist of trenches, pits and shallow shafts. The bedrock is similar to that of the Rock Corral area and consists essentially of biotite-rich rock in plutonic crystalline granitic rocks. Anomalous radioactivity is apparently related to biotite concentrations in the plutonic and metamorphic rocks.

A sample of metamorphic rock submitted to the U. S. Geological Survey laboratory by Mr. D'Alessandro contained 0.12 percent uranium.

Red Devil Claim (70). Radioactivity slightly above background count has been found on the Red Devil claim, Danby district, in the NW¼, T. 6 N., R. 18 E. (projected), about 12 miles southeast of Essex in San Bernardino County. When examined in 1952, the was owned by L. M. Donnel of Fenner, California was under lease to R. A. Mesick of Cathedral City, fornia. Exploration workings consisted of two sh pits in a mineralized shear zone.

Bedrock in the vicinity of the pits consists of g of Jurassic (?) age, although elsewhere on the metamorphic rocks of possible pre-Cambrian age a posed. A shear zone which strikes N. 30° W. and 80° SW, and is seen only in the granitic rocks, co discontinuous patches of vein material composed inantly of silica, lesser amounts of stibnite, cinn stibiconite (?), iron oxides, and small amounts unidentified uranium mineral. Locally, along the zone, the wall rock is hydrothermally altered and blea

Only small quantities of radioactive material found when the property was tested for gamma-r tivity; all of the anomalous radioactivity is confi the mineralized shear zone. A select specimen, whic tained abundant stibnite, cinnabar, and stibiconite assayed 0.076 percent equivalent uranium and percent uranium.

Steiner Claims (80). The Steiner claims are typical desert terrain of low barren hills in sec. 2 N., R. 7 E., San Bernardino County. The proj owned by Carl Steiner of Bellflower, California, m reached by following the Giant Rock road from J Tree, California, for 6.2 miles and then turning on a dozer trail for half a mile to the low, rolling Development of the property consists only of loc work.

Abnormal radioactivity, a maximum of 1.0 M is present along a small fault in dark-colored b schist, and is attributed to thorium-bearing min probably monazite and allanite, associated with th tite. A select sample collected by the U. S. Atomi ergy Commission indicated an equivalent uranium tent of 0.055 percent.

Copper Mountain Claim (81). The Copper M tain claim is approximately 8 miles northwest of Tw nine Palms, California, in sec. 19, T. 1 N., R. 8 E. Bernardino County. The owner is Carl Kramer of T tynine Palms, California. Development of the proj when visited by the U. S. Atomic Energy Comm in January 1954, consisted of several shallow disc pits.

Bedrock in the vicinity of the claim consists of d and gneiss (?) intruded by fine-grain granite. R activity, as high as 1.0 MR/hr, was detected alo shear zone in these rocks; the shear zone was trace feet. Although no uranium or thorium minerals identified at the time of examination, uranothorite, ite, and allanite, associated with quartz, hematite,

Table 7. Sampling data, Copper Mountain claim, San Bern County, California.

Sample number	Description and locality	eU_3O_8 (percent)	U_3O_8 (percent)
100513	5.3′ channel sample	0.25	0.066
100513A	9.0′ channel sample	.05	.020
100513B	2.5′ channel sample	.06	.023
100515	Grab sample of talus material (highly radioactive)	.28	.130
100515A	Grab sample at top of hill	.24	.028

agnetite, and muscovite, have been reported by the
ic Energy Commission which collected samples
this property.

Homestretch Group (82). The Homestretch group
laims, consisting of seven claims owned by Carl H.
dersen, et al., of Twentynine Palms, California, are
r Copper Mountain in secs. 19 and 30, T. 1 N., R.
8E., San Bernardino County. Workings consist of a
5-foot prospect shaft on the Homestretch No. 1 claim,
1 20-foot prospect shaft and 10-foot crosscut on the
mestretch No. 3 claim.

Anomalous radioactivity, attributed to the presence
thorium-bearing monazite and allanite, is as much
20 MR/hr; background count in the vicinity is
15 MR/hr.

The claims are underlain by light tan to pinkish-tan
ane or granodiorite that is gneissoid locally. Folia-
tion in the granitic rock, produced by parallel arrange-
ment of biotite sheets, strikes N. 35° W. and dips as
ic as 63° NE at the prospect workings. Radioactivity
highest in biotite-rich portions of the gneissoid gra-
ic rock. Select specimens collected by the U. S. Geo-
ical Survey and the U. S. Bureau of Mines contained
ch as 0.005 percent U_3O_8 and 0.33 percent ThO_2.

Live Oak Tank Area (84). The Live Oak Tank area,
verside County, is in the Joshua Tree National Monu-
ment about 12 miles south of Twentynine Palms. The
area is accessible over paved and gravel roads. It was
examined on December 13, 1948, by D. G. Wyant of the
U. S. Geological Survey.

Bedrock in the area, as mapped by Miller (1938),
consists dominantly of crystalline metamorphic and
plutonic rocks of pre-Cambrian age, and intrusive quartz
monzonite of Jurassic(?) age. The pre-Cambrian rocks
have been classified by Miller as metasedimentary rocks,
Gold Park gabbro-diorite, Palms granite, Pinto gneiss,
and monzonite porphyry; the Pinto gneiss is a meta-
morphic-igneous complex made up dominantly of meta-
morphic facies of the Gold Park gabbro-diorite, Palms
granite, and some metasedimentary rocks. The quartz
monzonite of Jurassic(?) age, named the White Tanks
monzonite by Miller, is medium- to coarse-grained,
massive, and homogeneous; some variations in grain
size and a few basic inclusions occur near the margins
of the monzonite masses. Thin sections show the bulk of
the rock to be composed of quartz, microcline, micro-
perthite, and oligoclase. The accessory minerals sericite,
calcite, apatite, and titanite constitute 1 percent by
volume of the rock. Zircon and allanite were also
observed, by Miller, in thin sections from all the for-
mations except the Gold Park gabbro-diorite.

Black sand in the dry wash at Live Oak Tank is of
recent age and contains monazite. The sand occurs on
the surface of the dry wash in discontinuous patches.
The patches range from a few inches to several feet in
length, and from 1 mm to half an inch in thickness.
Patches of black sand also are in the wash 50 to 100
feet downstream from outcrops of the White Tank
monzonite of Miller (1938), and some pockets of blank
sand were seen in natural riffles on the monzonite. Most
of the dark concentrates were derived from the mon-
zonite, and probably were deposited on the surface of
the dry wash in the closing stages of the last flash flood.

Table 8. Sampling data, Live Oak Tank area, Riverside County, California.

Sample number	Analyses			Description
	Field	Laboratory		
	* (MR/hr)	eU (percent)	U (percent)	
DW-79:				
246	0.04	0.008	0.003	3′ chip, hornblende-biotite inclusion (Pinto gneiss) in White Tanks monzonite
247	.05	.005	.001	Placer, Recent gravel, incl. black sand; average material
248	.03	.002	.000	10′ chip, schist inclusion (Pinto gneiss) in White Tanks monzonite
249	.02	.004	.000	Grab, chips of White Tanks monzonite from area 50′ square
250	.05	.011	.001	Placer, black sand skimmed from surface dry wash
251	.02	.004	.003	Grab, chips of White Tanks monzonite from area 50′ square
DW-80:				
252	.60 app.	.035	.005	Grab, biotite-feldspar porphyritic sill or dike in Pinto gneiss

* Average reading at the outcrop. Background included. Average background was 0.025 MR/hr.

Tests of samples of the blank sands from five localities and of outcrops of White Tanks monzonite of Miller (1938) at thirteen localities indicate gamma-ray activity only slightly above background. Tests of the Palms granite of Miller (1938), including a porphyritic phase, and the porphyritic monzonite of Miller (1938) indicate that these rocks are essentially non-radioactive. Radioactivity testing of the Pinto gneiss of Miller (1938) was confined to an area underlain dominantly by a complex of fine-grained metamorphic rocks and dikelets of quartz biotite granite which locally are pegmatitic. Most of the Pinto gneiss is only weakly radioactive, but in one small area, readings of as much as 20 times background were recorded. The more radioactive areas of the Pinto gneiss are characterized by a higher proportion of injected granitic rock and associated pegmatite.

Six samples of black sand, White Tanks monzonite, and Pinto gneiss were analyzed. The analyses indicate an equivalent uranium content ranging from 0.002 to 0.035 percent and a uranium content ranging from 0.000 to 0.005 percent. Most of the anomalous radioactivity of the Live Oak Tank area is attributed largely to thorium in monazite and xenotime, and to a lesser extent to radioactive titanite, zircon, and biotite.

Uranus Claims (83). The Uranus claims are southwest of Pinto Basin in sec. 6, T. 2 S., R. 10 E., San Bernardino County. The property, consisting of four claims, is owned by C. J. Bassler, Jr., and F. E. Bassler of Twentynine Palms, California. Workings on the property consist of a prospect cut on the Uranus No. 2 claim and another cut on the Uranus No. 4 claim.

The area is underlain by Pinto gneiss of Miller (1938), a metamorphic-igneous complex composed of granite gneiss, gabbro-diorite, and dark greenish-gray quartz-biotite schist. The plane of foliation of the biotite schist strikes N. 30-35° W. and dips 50-60° SW. Radioactive minerals occur in biotite-rich portions of the schist. They

have not been identified, but probably are thorium-bearing allanite and monazite.

Abnormal radioactivity in the prospect cuts are as high as 1.8 MR/hr; background reading is 0.05 MR/hr. Minor radioactivity was noted along the strike of portions of the biotite-rich schist for 2,500 feet between the two prospect cuts.

Assays of chip samples collected by the U. S. Bureau of Mines and the U. S. Geological Survey indicate a uranium content of less than 0.005 percent and a ThO_2 content of not more than 0.015 percent. Select samples collected by the U. S. Atomic Energy Commission contained equivalent uranium as high as 0.035 percent.

Desert View Claim (85). The Desert View claim is in secs. 31 and 32, T. 5 S., R. 10 E., San Bernardino meridian, about 2 miles N. 25° W. of Cactus City, Riverside County. In 1952, the property was owned by Mr. Willis Murphy and Mr. E. H. Kreuger of Yucaipa Valley, California. Exploration workings on the property consist of five small pits, a 35-foot trench, and several bulldozer cuts.

Bedrock exposed on the claim consists of banded, pre-Cambrian gneiss that has been intruded by several 4-foot dikes of aplite. A radioactive, rare-earths-bearing mineral, probably monazite, is erratically and sparsely distributed in the biotite gneiss; no abnormal radioactivity was found in the dikes.

Assay of two selected specimens collected in pits adjacent to the discovery monument indicate an equivalent uranium content of 0.13 and 0.15 percent, and a uranium content of 0.01 and 0.005 percent, respectively.

Granite Mine (86). The Granite mine is in sec. 1, T. 6 S., R. 15 E., and may be reached by following a dirt road for 3 miles in a southwesterly direction from Desert Center, California. The mine is owned by J. Rakocy of Los Angeles and H. K. Hennigh of Desert Center, California. Anomalous radioactivity, ranging from 5 to 10 times background count was detected in the workings from which gold and silver were mined as early as 1894. The workings consist of approximately 2,000 feet of drifts, shafts, and crosscuts. Unidentified radioactive minerals occur in a fault zone in granite. Highly altered fault gouge in this zone contains copper, iron and manganese minerals. Felsitic dikes also cut the granite.

Aurora No. 1 Mine (87). Anamalous radioactivity as high as 10 times background count is present at the property of Tyler Bennett and A. H. Hummel of North Hollywood, California. The property is located in sec. 26, T. 6 S., R. 14 E. Development workings consist of two shallow shafts. Unidentified radioactive minerals occur in a copper-stained quartz vein in granite. The vein probably was worked in the past for gold.

Crescent Mine Claim (88). The Crescent Mine claim, owned by M. C. Adison of Long Beach, California, is on the southwest flank of the Chuckwalla Mountains about 7 miles south of Desert Center, Riverside County, California. Unidentified radioactive minerals appear to be concentrated along a minor fault between gneissic granite and fine-grained granite. Radioactivity was noted in a zone of iron- and manganese-stained altered rock that is 12 feet thick and traced for 150 feet. Radioactivity 10 times background count is concentrated in a zone 2½ feet thick within the zone of altered rock. Samples collected by the U. S. Atomic Energy Comm assayed as high as 0.094 percent equivalent urani

Lady Katy Claims (89). The Lady Katy gr claims, owned by Larry Cronkhite and Grover Bu of Brawley, California, are on the southwest flank Chocolate Mountains in sec. 7, T. 9 S., R. 14 E., Im County. It is 8 miles inside the boundary of the aerial gunnery range. The bedrock exposed in th consists of granite, diorite, and aplite. The rocks these faults or fractures have been hydrothermal tered and are radioactive. Metatorbernite (?) occur quartz and iron oxides in the altered rock. Where torbernite is seen, the radiation intensity amounts times background count. Channel samples collect the U. S. Atomic Energy Commission have indic uranium content as high as 0.374 percent U_3O_8.

Tenn-Cal Group (90). The Tenn-Cal group, c ing of six unpatented claims, is in sec. 14, T. 12 19 E., Imperial County. It is owned by Horace E. ber of Long Beach, California, and Ray Downing Angeles, California. The workings consist of sever pits and one open cut, probably worked in the pa kyanite and possible pyrophyllite.

The bedrock exposed in the area consists of s metasediments and volcanic rocks. Abnormal ra tivity, as high as 3.4 MR/hr, occurs in an alteratio in the schist and metasediments and appears to be ciated in places with kyanite. Torbernite (?) and uranium minerals were observed by the U. S. A Energy Commission and samples collected fron property indicate an equivalent uranium content as as 0.293 percent. Other minerals present include gy minor amounts of fluorite, pyrophyllite (?), and and manganese oxides.

Lucky Star Claim (91). The Lucky Star claim, is probably the same property known as the McK clay deposit, is in sec. 36 (?), T. 12 S., R. 19 E. Bernardino meridian, about 10 miles northeast of Gl Imperial County. Glamis, which is on the Southern cific Company right-of-way, is the nearest railroad ping point. Excavations at the property, in April consisted of a pit 20 feet wide and 50 feet long an small prospect pits. The property is held by locatio S. C. Wright of Porterville, California.

Bedrock on the claim consists of pre-Cambrian quartzite and quartz mica schist which have been fo faulted, and subsequently intruded by felsic dikes, and small volcanic necks or plugs of Tertiary age. metamorphic rocks, as well as the felsic intrusive r are locally bleached and hydrothermally altered. areas of hydrothermal alteration contain, in additi unidentified clay minerals and quartz, notable quan of talc, gypsum, calcite, and lesser amounts of torbe or autunite, carnotite, psilomelane, and hydrated oxides. Most of the carnotite occurs in the altered intrusives, and most of the torbernite (?), and all o talc, in the altered metamorphic rocks.

Assays of three channel samples collected by the logical Survey in one small pit on the property ind an equivalent uranium content of 0.028, 0.077, and percent and a uranium content of 0.021, 0.076, and percent, respectively. The quantity of material of grade is small. Traverses for radioactivity elsewher

aim gave Geiger counter readings the same as, or lightly above, the background count.

erican Girl Mine (92). Radioactivity is five times kround count at the American Girl mine, about 3 le northeast of Ogilby, California, in secs. 18 and 19, 1 S., R. 21 E., Imperial County. The property is n l by A. F. Quasebarth of Winterhaven, California. e mine, a quartz vein in Tumco gneiss contains ate, mica, and pyrophyllite.

Sierra Nevada Province

a general way, the Sierra Nevada province may be scbed as a single fault block of great magnitude, ic represents the dominant mountain range of Cali- n. The province is bounded on the east by the Basin nes province, on the west by the Great Valley of lifornia, and on the south by the Garlock fault. On orth, the province is terminated where the Cenozoic nic rocks of the Cascade Range and the Modoc atau overlie the rocks characteristic of the Sierra vada.

The oldest rocks in the province consist of a sequence Paleozoic sedimentary rocks, most of which have been nmically metamorphosed to phyllite, quartzite, re- stallized limestone, amphibolite and amphibolite nis, quartz-mica schist, and graphite schist. Strati- aphically above the Paleozoic rocks is a thick sequence Mesozoic slate or phyllite and various types of meta- lcanic rocks. The Paleozoic and Mesozoic rocks, ex- se predominantly in the west and northwest parts of e province, have been invaded by great masses of plu- nic rock composed largely of granodiorite and quartz- monite but including other plutonic rock types and ay, small masses of pegmatite. Quartz veins, many which contain base-metal sulfides and gold, were in- duced into the Paleozoic and Mesozoic rocks during e waning stages of plutonic invasion.

Although radioactive minerals are widely distributed roughout the province, significant concentrations are re Hutton (1951a), Pabst (1954), Shawe (unpub- he report), George (1951), and others have identified rious minerals including allanite, thorite, monazite, anerite, and uranium-bearing ilmenite as sparsely ssminated accessory minerals in the plutonic rocks d as detrital grains in placer concentrates. Uraninite d uraconite have been reported by Rickard (1895) on the Rathgeb mine (Calaveras County), and radon s a radioactive product derived from the disintegra- n of uranium-bearing materials, has been reported on the General U. S. Grant mine (Tuolumne County). Several uraninite crystals, as large as a quarter of an h n diameter, have been submitted by prospectors to e U. S. Atomic Energy Commission field office in kersfield, California. These crystals were reported to ve been collected from pegmatite in the vicinity of ekenridge Mountain (T. 28 S., R. 32 E.) in Kern unty. Positive identification of one uraninite crystal s made by X-ray diffraction methods at the U. S. Geo- cal Survey laboratory in Menlo Park, California.

Autunite in commercial quantity was discovered by ny Brooks Mann and associates of Taft, California, the Kern River Canyon, 35 miles northeast of Bakers- ld Kern County, during the early part of 1954. A nnel was subsequently driven southeastward along the ary vertical shear zone in granodiorite, and on July 31, 1954, a 46-ton shipment of uranium ore, averaging 0.62 percent U_3O_8, was made from the Miracle mine. During September 1954, the property was sold to the Wyoming Gulf Sulfur Corporation and by December 1954 mining operations were resumed. Several similar occurrences of autunite are within a few miles of the Miracle mine.

An occurrence of primary uranium minerals associated with minor secondary uranium minerals has been examined by the Atomic Energy Commission at the Embree property (T. 27 S., R. 33 E.), Kern County, where uranium occurs in quartzite near a quartzite-gneiss contact.

Primary uranium minerals and metatorbernite occur with sulfides in a brecciated fault zone cutting granodiorite at the Truckee Canyon group near Floriston, Nevada County. Uraninite may occur with sulfides in smoky quartz at the Rainbow claim (Madera County).

Occurrences of torbernite associated with metazeunerite (?) disseminated in iron oxide has been reported from quartz veins in granodiorite in Plumas County; secondary copper minerals are also present.

Anomalous radioactivity associated with spring deposits have been reported from the Stokes and Stowell properties in Plumas County and from the Allen property in Kern County. Radium has been identified as the radioactive substance in the Stokes and Stowell property and is probably the source of radioactivity at the Allen property.

Examinations for radioactivity of a number of other mine properties in the province by the U. S. Atomic Energy Commission and the U. S. Geological Survey, including gold properties in the Mother Lode belt and a few contact-metamorphic tungsten deposits, have failed to detect any significant gamma-ray activity.

Stokes and Stowell Properties (1). The Stokes and adjoining Stowell properties are in sec. 24, T. 25 N., R. 8 E., Mt. Diablo meridian, about 8.5 miles northwest of Quincy, Plumas County. Several occurrences of radioactive material on the properties are within a few hundred feet of the Feather River highway (State Highway 24).

Bedrock in the area consists of steeply dipping marine metasedimentary rocks including slate, foliated and shaly limestone, fine-grained phyllitic tuffs (?), and quartzite. The rocks are probably part of the Calaveras formation of Mississippian age. Numerous northwest-trending faults are exposed in road cuts along the Feather River highway. Locally, on some faults, hot springs are present; elsewhere along the faults deposits of limonitic and manganiferous sinter indicate the former position of hot springs.

Radioactivity tests of the thermal waters at four active springs gave counts the same as, or only slightly above, background, but similar tests of the limonitic sinter at four inactive springs gave counts of as much as 16 times background. A selected sample of some of the most radioactive limonitic sinter assayed 0.66 percent equivalent uranium and 0.001 percent uranium; analyses made by the U. S. Geological Survey showed radium to be the source of most of the abnormal radioactivity.

Perry Jones Group (2). The Perry Jones group of 61 claims, in sec. 13, T. 24 N., R. 16 E. and sec. 18, T. 24 N., R. 17 E., may be reached by following the special

service road north from Chilcoot, Plumas County, for 4.6 miles to a junction where the right fork continues for 11.1 miles to the claims in the vicinity of Crystal Peak. The property is owned by Mr. Perry L. Jones of San Francisco. Workings on the claims consist of surface excavations made by means of a bulldozer, and one or more old copper prospect tunnels. No shipments of radioactive ore have been made as of January 1955.

Weathered granodiorite comprises the bedrock in the area. It is cut by several roughly parallel quartz veins, as much as 4 feet thick, that have a north to northeast strike and moderate dips to the east or southeast. Metazeunerite has been identified in quartz veins on the Buzzer claim of the Perry Jones group. This is the first reported occurrence of metazeunerite in California. Torbernite (?) is erratically distributed in some of the quartz veins as encrustations on fracture surfaces and as small cavity fillings. Several quartz veins contain chrysocolla, malachite, and iron oxide, but no visible secondary uranium minerals. Radiation intensities are not uniform along the quartz veins, but range from slightly above background count to as much as 3.0 MR/hr. Anomalous radioactivity is also present in sheared granodiorite where intensities as high as 1.0 MR/hr were recorded. One 10-pound specimen of quartz collected from the Buzzer claim by Mr. Jones contained abundant iron oxide and registered 10.0 MR/hr on a Geiger counter.

Six samples were collected by the California Division of Mines and assayed by the Geological Survey.

Table 9. Sampling data, Perry Jones group, Plumas County, California.

Sample number	Description and locality	eU (percent)	U (percent)
PLJ-8	Decomposed granite—representative sample from Lucky Day No. 1 claim, Sec. 13, T. 24 N., R. 16 E.	0.14	0.14
PLJ-9	Quartz vein material, copper and iron stains; Climax No. 1 claim, Sec. 18, T. 24 N., R. 17 E.	0.14	0.15
PLJ-10	Quartz vein material with copper stain, Lucky Day No. 1	0.077	0.11
PLJ-11	Quartz vein material with torbernite (?) Georgian No. 1 claim, Sec. 24, T. 24 N., R. 16 E.	0.089	0.094
PLJ-12	Decomposed granite (in shear zone) with torbernite (?), Lucky Day No. 1 claim, Sec. 13, T. 24 N., R. 16 E.	0.17	0.17
PLJ-13	Quartz vein material with green secondary uranium minerals (metazeunerite or torbernite) and copper stain, Buzzer No. 1 claim, Sec. 13, T. 24 N., R. 16 E.	0.65	0.72

Guidice Mine (3). The Guidice mine, formerly known as both the Mohawk copper mine and the Last Chance mine, is on the west slope of Adams Mountain in sec. 25, T. 24 N., R. 16 E., Plumas County.

According to E. M. Boyle (1918), copper was discovered on this property in 1905 and mining operations were intermittent until 1917. Workings at that time included a 180-foot inclined shaft with 315 feet of drifts on three levels and about 240 feet of crosscuts. The vein had been stoped from the 120-foot level north to the tunnel level. Approximately 1,000 tons of copper ore, averaging 6 percent copper, was shipped prior to 1917. The deposit consists of a main (Mohawk) vein composed of copper-bearing quartz in granitic rock. The vein averages 4 feet in thickness, strikes N. 20° E., dips 80° NW., and is 3,000 feet in length at the surface. A northwest-trending vein east of the main vein di NE. It was cut on the tunnel level and probably sects the main vein at depth.

The mine was leased in 1954 by Perry L. Jo San Francisco, California, who submitted samples U. S. Geological Survey that contained secondar per minerals, molybdenite, and unidentified radio minerals. Abnormal radioactivity amounting to a imum reading of 0.15 MR/hr was noted by the Atomic Energy Commission in a small trench ne shaft. Radioactive specimens containing chrysocolla achite, molybdenite, and scheelite have come fro mine. Most of the workings are inaccessible at the p time, and, therefore, an underground examinatio radioactivity has not been made.

Brown Property (4). Anomalous radioactivity to 35 times background count was measured by the Atomic Energy Commission at the C. O. Brown pro near Chilcoot, Plumas County. Old mine working sist of a shaft 100 feet deep and drifts of unk length. Most of the workings are not accessible, a underground examination of the mine has not completed. The highest radioactivity at the prope in pegmatite in granitic rock, and is associated wit per and molybdenum minerals.

Truckee Canyon Group (7). The Truckee C group, comprising the Green Boy and Floriston c are near U. S. Highway 40 about 13 miles ea Truckee, California, in sec. 13, T. 18 N., R. 17 E., N County. The claims are owned by the Sierra Powe Light Company and leased to Richard Joseph and E. Harris. The property is in rugged mountainou rain on the east slopes of the Sierra Nevada.

Abnormal radioactivity at the Green Boy c amounting to 10 times background count, is asso with a brecciated and altered shear zone in granod of Jurassic age. The shear zone has been prospecte gold by means of a 70-foot adit. Significant radioac is detectable on the surface for as much as 200 north from the portal. Maximum radioactivity was in a north-trending quartz-pyrite vein, 3 inches thi an iron-stained breccia along the west side of the Metazeunerite (?) occurs as minute cavity fillings i rock. Manganese oxides and fluorite are also prese the vein. The richest sample from the Green Boy c assayed by the U. S. Atomic Energy Commission tained 0.5 percent U_3O_8.

Maximum radioactivity on the Floriston clai associated with a narrow fault zone that is expose a length of 100 feet in what appears to be gran sediments. A radioactve sample submitted to the Atomic Energy Commission consisted mainly of q a blue sodic amphibole and minor amounts of p chalcopyrite, and malachite. Anomalous radioactivi the sample is believed to be caused by unide primary(?) uranium-bearing minerals disseminat the fine-grained sulfide minerals. The highest sample collected by the Atomic Energy Comm contained 0.13 percent U_3O_8.

Rathgeb Mine (8). According to Rickard (1 acicular black crystals of pitchblende (uraninite) a yellow uranium ochre (uraconite) are associated spongy gold and clay minerals at the Rathgeb mi

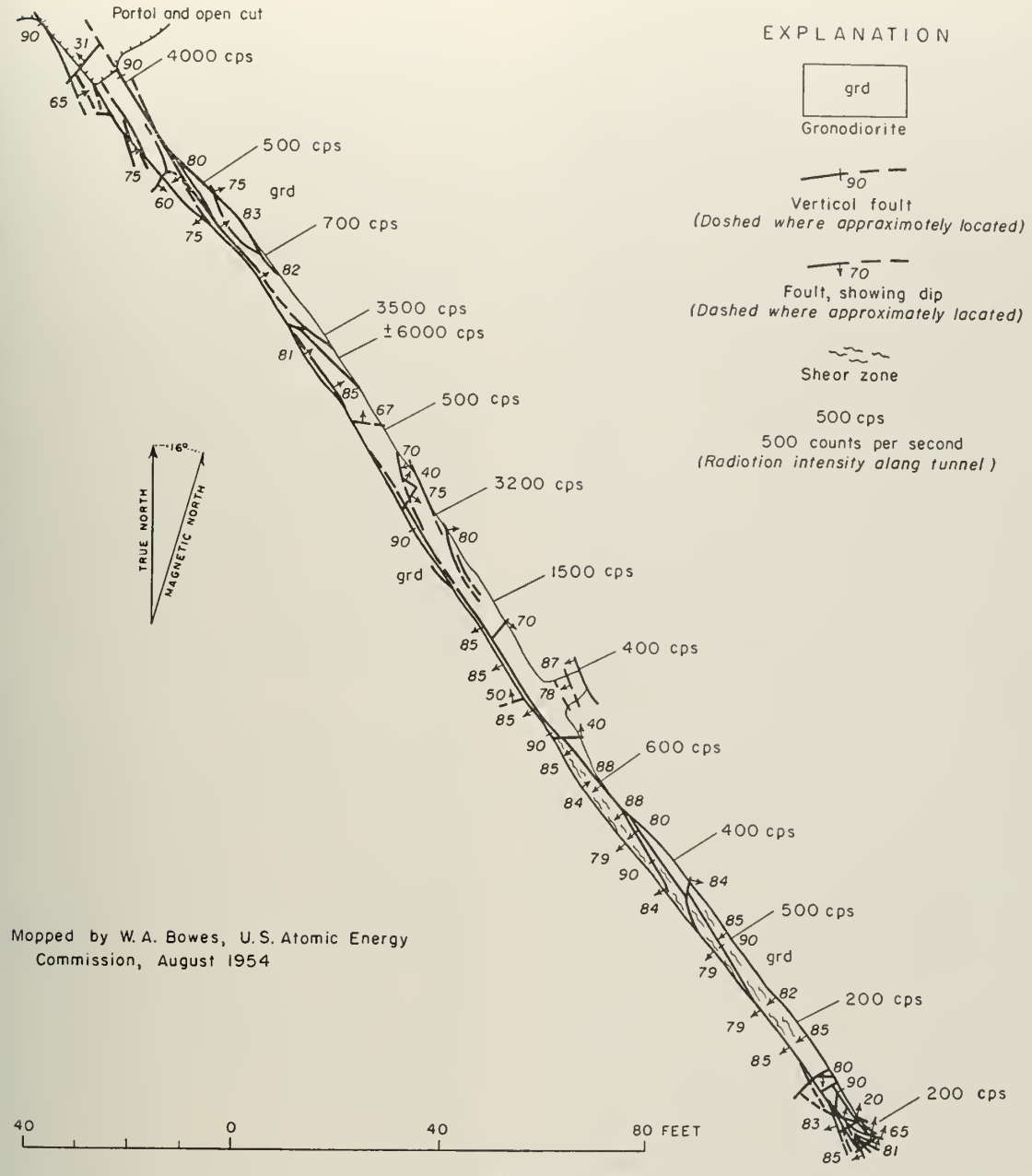

FIGURE 4. Plan of No. 5 tunnel, Miracle mine, Kern River Canyon area, Kern County, California.

W¼ sec. 34, T. 4 N., R. 12 E., Mt. Diablo meridian, e miles south of San Andreas, Calaveras County. T workings consist principally of a 220-foot shaft, ic, at the time of field examinations in 1947 and 4 was caved and inaccessible. A radioactivity recon- s nce of the dump, and tests of a quartz vein exposed the shaft collar, indicate only low gamma-ray ty and fail to confirm the presence of uraniferous al.

neral U. S. Grant Mine (9). Radon gas has been fied in abandoned workings at the General U. S. (or Sunnyside) mine in sec. 27, T. 3 N., R. 15 E., Diablo meridian. This Tuolumne County mine, was worked for gold presumably associated with netal sulfides in quartz, is in crumpled and iron-stained mica schist of Mississippian(?) age. Examination of the property failed to determine the source of the radon gas.

Rainbow Claim (11). The Rainbow claim, Jackass district, Madera County, in T. 4 S., R. 24 E., is approximately 16 miles southeast of Camp Curry, Yosemite National Park. The property is accessible by mountain trail from Jackass Meadows (Madera County). In July, 1952, workings on the property consisted of a 6-foot pit and a 2-foot discovery pit.

Minute quantities of a radioactive mineral, possibly uraninite, are associated with pyrite, chalcopyrite, tetrahedrite(?), bornite(?), magnetite, iron oxides, and smoky quartz in pegmatite which is intrusive into granodiorite of Jurassic(?) age. A sample of the most

radioactive material, which contained appreciable quantities of quartz and base-metal sulfides, assayed 0.003 percent uranium.

Miracle Mine (23). Uranium was first discovered in the Kern River Canyon area, about 35 miles northeast of Bakersfield, California, in sec. 20, T. 27 S., R. 32 E., Kern County, in January, 1954. Henry Brooks Mann and associates of Taft, California, discovered the deposit while prospecting along State Highway 178 (south side of Kern River Canyon) with a carborne scintillation counter. Mr. Mann and his partners subsequently staked 20 claims, originally called the Buckeye group, and shortly thereafter began to drive a drift adit on the No. 5 claim. The adit was advanced 255 feet before the locators sold the mine to the Wyoming Gulf Sulfur Corporation in September, 1954. Other development workings include several cuts southeast of the portal. The new owners then widened and timbered 170 feet of the No. 5 adit and installed track and ventilation pipe prior to additional mining operations.

Bedrock in the area consists of the Isabella granodiorite of Miller (1931) of late Jurassic or early Cretaceous age, varying locally from granite to quartz diorite. The dominant regional structures in the vicinity of the Miracle mine are conspicuous fractures having a northwest strike and nearly vertical dip. The shear zone exposed at the portal of the No. 5 adit strikes N. 33° W. and dips vertically. The thickness of the mineralized rock ranges up to approximately 2 feet.

Autunite has been tentatively identified as the important uranium ore mineral, occurring as erratic disseminations in iron-stained clay gouge and decomposed granodiorite along the shear. As of December, 1954, no uranium minerals other than autunite have been identified at the mine. Notable is the lack of common gangue minerals. Fluorite has been identified in the shear zone by the U. S. Atomic Energy Commission. The fluorite may have been deposited with uranium from a low temperature hydrothermal solution deficient in silica and calcium carbonate.

Grab samples of clay gouge and decomposed granodiorite, collected by the U. S. Atomic Energy Commission along the mineralized shear zone shortly after discovery of the deposit, contained as much as 0.48 percent U_3O_8. On July 31, 1954, Mr. Mann and associates shipped a 46-ton carload of uranium ore that averaged 0.62 percent U_3O_8 to the Vitro Uranium Company of Salt Lake City, Utah.

Kergon Group (21). The Kergon group of nine claims, located by J. Kerns and W. Waggoner of Taft, California, and later sold to the Great Lakes Oil and Chemical Company of Los Angeles, is in sec. 20, T. 27 S., R. 32 E., Kern County, approximately 3,000 feet southwest of the Miracle mine. The Great Lakes Oil and Chemical Company enlarged the original discovery cut to a depth of 10 feet with a bulldozer. Additional uranium was found 200 feet north of the original discovery and a 12-foot pit was excavated. A crosscut adit was started about 20 to 30 feet lower in elevation and was driven into the hill under the second pit. A 25-foot drift was driven northward from this crosscut.

Abnormally high radioactivity (1,200 counts per second on a scintillation counter) was measured by the

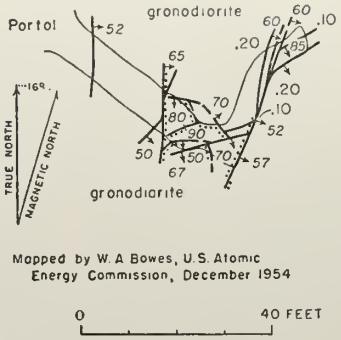

FIGURE 5. Plan of Kergon No. 1 adit, Kergon group, Ke Canyon area, Kern County, California.

U. S. Atomic Energy Commission along a fractu in soft weathered biotite granite. The fractu strikes N. 50° W., dips 75° NE, and is 5 feet exposed in the discovery cut. A northeast-t shear zone was exposed in the second cut. Grab collected from this cut by the Atomic Energy C sion contained as much as 0.18 percent U_3O_8. One of fault gouge material from the underground w contained 1.08 percent U_3O_8, 1.1 percent Ca 1.84 percent molybdenum.

As of December 1954, uranium-bearing rock fr workings is being stockpiled on the property.

Wayne Case Property (22). Autunite was dis on July 31, 1954, about 1½ miles west of the mine and 3 miles west of Miracle Hot Springs 25 (?), T. 27 S., R. 31 E., Kern County. Mr. Case of Taft, California, made the discovery. The ite occurs in an iron-stained shear zone in bre granodiorite, similar to the occurrence at the mine. The shear zone strikes N. 35° W. and di NE. Radioactivity measurements by the U. S. Energy Commission indicated a maximum count MR/hr and an average count of 0.5 MR/hr for posit; background amounted to 0.035 MR/hr. samples of the uranium-bearing rock assayed Atomic Energy Commission contained as much percent equivalent U_3O_8 and 0.61 percent U_3O workings at the time of examination consisted open cuts.

Last Chance Claim (24). The Last Chance c on the east side of Clear Creek about a quarter of east of Miracle Hot Springs, California, in sec. 22 S., R. 32 E., Kern County. It is owned by Mr. Martin of Miracle Hot Springs who worked it ori for tungsten before detecting anomalous radioacti one of the surface cuts. Bedrock in the vicinity c of tactite, marble and granite. Radiactivity m ments by the U. S. Atomic Energy Com amounted to a maximum value of 0.5 MR/hr. samples contained no more than 0.055 percent U_3 uranium minerals have been identified.

Dancing Devil No. 16 Claim (20). The D Devil No. 16 claim is about 7 miles west of Mirac Springs in sec. 23, T. 27 S., R. 31 E., on the steep slope of the Kern River Canyon, Kern County owned by J. A. Brinkley, Ray Linton, and Ron of Los Angeles, California. Workings on the pr consist of one 10-foot pit in the pegmatite. Ano

ctivity, amounting to a maximum value of 0.5 /r, appears to be confined to large biotite plates egmatite in granite. No uranium minerals were tied. Mr. Brinkley submitted a select specimen of tite to the U. S. Atomic Energy Commission for which contained 0.25 percent U_3O_8.

Dog Claim (25). The Sun Dog claim is about es west of Havilah, California, in sec. 9, T. 28 S., E., Kern County, and is owned by Harold Hart of Beach, California. Workings consist of 50 feet of ground workings and three surface cuts; all but rface cut were made previously by gold prospec- Bedrock in the vicinity consists of granite. Ano- s radioactivity as high as 1.7 MR/hr was measured U. S. Atomic Energy Commission in a pegmatite aving a northeast strike and a low angle dip to utheast. The pegmatite is 10 to 20 feet thick and osed along its length for as much as 600 feet.

yite and arsenopyrite (?), but no uranium min- were seen on the property. A select sample of the ctive material assayed by the U. S. Atomic Energy ission contained as much as 0.14 percent equiva- $_3O_8$ and 0.105 percent U_3O_8.

ttenbarger Prospect (18). The Wattenbarger p ty is about 5 miles west of Greenhorn Summit in sec. 23, T. 25 S., R. 31 E., Kern County, and ed by Doyle Wattenbarger and James Stewart of e, California. It is in heavily wooded mountainous at an altitude of about 5,000 feet. Workings on roperty consist of bulldozer cuts. Anomalous radio- y, a maximum of 0.25 MR/hr, was measured by U S. Atomic Energy Commission in pegmatite-aplite n granitic rocks of the Sierra Nevada batholith.

er Strand Claim (19). Anomalous radioactivity sent in white, impure Paleozoic (?) marble on the Strand claim in sec. 10, T. 25 S., R. 32 E., Kern y. The claim is leased by John C. Compton of o, California. Development work on the property sts of two adits, one 150 feet long, and the other 100 ng. Bedrock in the vicinity is marble, although e occurs east of the workings. The adits, entirely rble, were driven toward a tactite body reported to n scheelite.

dioactivity, amounting to a maximum value of 0.2 r was measured by the U. S. Atomic Energy Com- n along fractures and silt-covered floors of solution es in the marble. Abnormal radioactivity in the e is probably caused by the presence of radium or gas decay products deposited along fractures and vities in the marble by ground water. Specimens ted at points of highest radioactivity on the prop- were found to be only weakly radioactive when rements were again made several days after the ens were removed from the locality.

en Property (26). Abnormally high radioactivity sent at a calcareous spring deposit on the Allen rty situated along Erskine Creek in sec. 15, T. 27 33 E., Kern County. The property consists of four ented claims, and is owned by John Allen of Bod- California. The calcareous material fills fractures in ered granite and forms a hard limy cap at the ce. The calcareous rock occurs for several hundred along the base of the hillside north of the discovery cold spring now issues from the cut.

Maximum radioactivity, measured by the U. S. Atomic Energy Commission, occurs in black sooty material underlying the limy cap rock. A select sample of the sooty material assayed 1.30 percent equivalent U_3O_8 and 0.04 percent U_3O_8; a select sample of the limy cap rock contained 0.88 percent equivalent U_3O_8 and 0.01 percent U_3O_8. The anomalous radioactivity is probably caused by radium.

Embree Property (27). The Embree property is on the southwest slope of Laura Peak near Erskine Creek in sec. 24, T. 27 S., R. 33 E., Kern County. The property was located by Frank Lieber during September 1954 and sold to Gil Embree of Kernville, California, about a month later. Workings on the property consist of a discovery cut, an upper adit with 165 feet of workings, and a lower adit with 205 feet of workings. Approximately 5 miles of access roads and several bulldozer cuts and trenches constitute the remainder of the work. Mr. Embree drove the upper crosscut adit northwestward through gneiss and paragneiss, and crossed a contact between paragneiss and quartzite 95 feet from the portal. The contact is gradational through several feet of paragneiss and altered quartzite. About 45 feet of drifting to the northeast along the contact was completed before he abandoned the upper adit because of caving ground. A lower adit was driven through 150 feet of gneiss and paragneiss, and 55 feet of drifting northeastward along the contact was completed by December 1954.

The finding of highly radioactive specimens of quartzite float containing 7.5 percent equivalent U_3O_8 led to the discovery of the deposit. Samples of quartzite from the discovery cut assayed by the U. S. Atomic Energy Commission contained as much as 3.0 percent U_3O_8. Radiation intensities as high as 1.5 MR/hr at the surface cut and 3.0 MR/hr in the lower workings appear to be associated with dark gray to black streaks in quartzite closely adjacent to, and roughly parallel to, the gneiss-quartzite contact. Pitchblende (?) and gummite (?) have been tentatively identified as the important uranium minerals in the deposit. Sparse stains of yellow secondary uranium minerals are, in places, associated with the dark gray streaks in the quartzite. Fluorite is indicated in a sample from the workings assayed by the U. S. Atomic Energy Commission that contained 0.08 percent U_3O_8 and 1.1 percent CaF_2. Garnet is present in the gneiss and probably accounts for some of the reddish-brown iron oxide stains observed in both the gneiss and quartzite.

No shipments of uranium ore had been made from the property by December 1954.

Kervin Property (28). The Kervin property is about 9½ miles (direct line) southeast of Weldon, California, in sec. 23, T. 27 S., R. 35 E., Kern County, and is owned by Henry Kervin of Bakersfield, California. A prospect pit 10 feet deep is the only working.

Anomalous radioactivity, a maximum of 3.0 MR/hr, appears to be associated with a northeast-trending shear zone that dips steeply northwest. The hanging wall (west side) of the shear zone is granitic rock; the foot wall (east side) is metasediments. A minor shear zone branches northward from the main shear zone. It was sampled by the U. S. Atomic Energy Commission where torbernite and a minor amount of autunite was seen. A select sample contained 0.11 percent U_3O_8.

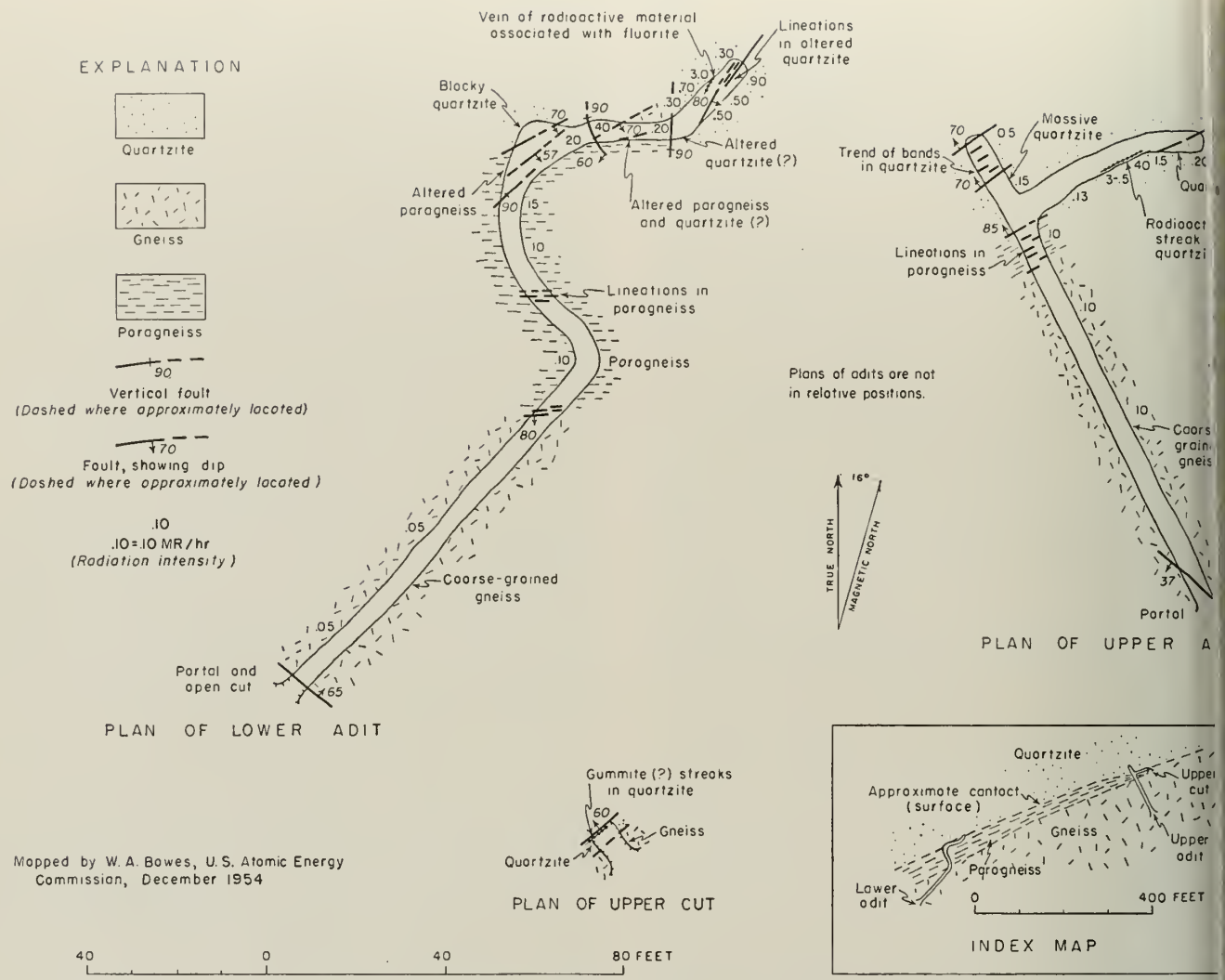

FIGURE 6. Embree property, Erskine Creek area, Kern County, California.

Silver Lady Claims (33). The Silver Lady claims, owned by Mr. and Mrs. Arthur J. DeLacy of Los Angeles, California, consists of three unpatented claims in Jaw Bone Canyon in the southern extremity of the Sierra Nevada, about 20½ miles north of Mojave, California, in sec. 10, T. 30 S., R. 36 E., Kern County.

Anomalous radioactivity is associated with a shear zone in granite of Jurassic (?) age and volcanic rocks of Pliocene (?) age. The shear zone was mapped as the Silver Lady fault by H. E. Nelson and R. L. Hillier of the Atomic Energy Commission. It is as much as 70 feet wide and over 2,000 feet long, strikes N. 70° W., and is nearly vertical. Radioactivity values as high as 30 times background count were detected along the north side of the Silver Lady fault and along small shears that branch northward from the main fault; these are in highly altered granite and fault breccia. Molybdenite is disseminated through parts of north-trending branch of the main shear zone near an 18-foot prospect shaft and also was observed on the dump. Meta-torbernite has been tentatively identified in a recent open cut near the shaft. Other minerals present in the fault zone include ferrimolybdite, pyrite, iron and manganese oxides, garnet, and quartz. A channel sample 4.5 feet wide fault breccia assayed by the U. S. Atomic Energy mission contained 0.071 percent U_3O_8. Highly specimens of breccia assayed as high as 31.10 p U_3O_8.

Coast Ranges Province

The Coast Ranges province, as described by J (1941), includes the coastal mountains that are bo on the north by the Klamath Mountains, on the by the Transverse Ranges, on the east by the Grea ley of California, and on the west by the Pacific San Francisco Bay further divides this provinc the northern Coast Ranges and the southern Ranges.

The Coast Ranges comprises a roughly elongat parallel system of mountains and intervening v that trend N. 30°-40° W. The trend is controll folding and faulting of the Jurassic (?), Cretaceou Cenozoic sedimentary and volcanic rock that un most of the area. A core of granitic rock, intrude schist, quartzite, gneiss, and limestone of the Sur of probable pre-late Paleozoic age (Taliaferro, 1 is exposed in parts of Monterey and San Benito Co

h southern Coast Ranges. The granitic rock is bor-
e on the east by the San Andreas fault, the dom-
nstructure in the region, and on the west by a com-
series of thrust faults and complex structures,
e mes referred to as the Nacimiento fault zone
ns, 1941).

e ndary uranium minerals were discovered late in
t several places in the southeastern extremity of
uthern Coast Ranges. Most of these discoveries
i the eastern foothills of the Temblor Range in the
ny of Taft and McKittrick, California. Autunite,
nite (?), uranophane (?) and possibly other
ary uranium minerals form thin coatings along
tres and bedding planes in shale and siltstone of
iocene age in the Taft-McKittrick area. Many of
eleposits appear to be in northwest-trending faults,
tularly where brecciation and iron-staining of the
s are conspicuous. The Taft-McKittrick uranium
spects are in an oil producing region and may be
tilled by some of the same structures that serve as
s for oil. Radioactivity of 0.5 MR/hr in an iron-
nl fault breccia was measured along a fault at the
ly Oil Company property. This fault is also re-
nble for the accumulation of oil southwest of the
fae radioactivity anomaly. The U. S. Atomic Energy
mission reports that "two nearby oil well logs show
tt radioactivity."

V other radioactive deposits have been reported in
uis Obispo County, 25 miles east of Santa Mar-
it, California. At the Wakefield property, torbernite
ntatively identified in a shear zone in fractured
nic rock; at the Santa Margarita prospect, radio-
iv iron-oxides stain fractures in sandstone of Ter-
ige overlying granitic rock.

Radioactive samples from the vicinity of Tassajara
t Springs, Monterey County, have been submitted
prospectors to the U. S. Geological Survey. Anoma-
s adioactivity in these samples appears to be asso-
te with concentrations of biotite in granite. Assay
a n these samples, which have lithologic similarities
thrium-bearing samples collected in the Rock Corral
a nd vicinity of Twentynine Palms, San Bernardino
nty, indicate that the source of radioactivity in the
ssara Hot Springs area is caused by thorium-bear-
dlanite or monazite in the biotite.

Nradioactive deposits have been reported from the
tern Coast Ranges.

Santa Margarita Prospects (41). The Santa Marga-
prospects are on private homestead land in sec.
29 S., R. 15 E., San Luis Obispo County. They
wned by Charles W. Lightfoot of Arroyo Grande,
lifornia. Workings at two different localities (about
uarter of a mile apart) include five cuts, a prospect
nd two rotary drill holes.

Radioactivity, as high as 1.5 MR/hr, was measured
t U. S. Atomic Energy Commission in iron-stained
cres in sandstone and siltstone of Tertiary age
mediately overlying rock of Jurassic(?) age. North-
strending faults, parallel to the San Andreas fault
are in the vicinity. No radioactive minerals were
nfied.

Wakefield Property (42). The Wakefield property,
La Panza Summit, is in secs. 2 and 3, T. 30 S.,
R. 16 E., San Luis Obispo County. It is owned by Ray Wakefield of Santa Maria, California. The only working is a 10-foot prospect pit.

Torbernite is distributed erratically in a shear zone 6 inches wide in granite. A maximum radiation intensity of 0.5 MR/hr was measured along the shear zone. The richest sample from the property assayed by the U. S. Atomic Energy Commission contained 0.177 percent U_3O_8.

Surprise No. 1 Claim (43). The Surprise No. 1 claim is about 7 miles northwest of McKittrick, California, in sec. 3, T. 30 S., R. 21 E., Kern County. It is owned by W. G. Boardman, Les Barker, John Munding, and Kenneth Hitchcock, Sr., of Taft, California. Two bulldozer trenches, one 250 feet long, and one 200 feet long, constitute the workings on the property.

Honey-yellow secondary uranium minerals coat fracture and bedding-plane surfaces of brown, iron-stained rocks of upper Miocene age in a fault zone that strikes N. 60° W. and dips 75° SW. Radiation intensities as high as 1.0 MR/hr were measured along the structure. Finely divided fluorite was tentatively identified in one sample. The most radioactive sample assayed by the U. S. Atomic Energy Commission contained 0.11 percent U_3O_8.

Loperna Property (44). The Loperna property is about 6 miles (direct line) northwest of McKittrick, California, in sec. 2, T. 30 S., R. 21 E., Kern County. It is owned by L. A. Loperna of Bakersfield, California. Location work was the only development of the property at the time of examination in December 1954.

Abnormal radioactivity, a maximum of 0.5 MR/hr, was noted in altered and brecciated siltstone and shale of late Miocene age adjacent to northwest-trending faults. Erratically distributed patches of yellow secondary uranium minerals coat fractures and bedding planes of the rocks. One sample submitted by Mr. Loperna contained 0.04 percent U_3O_8.

Mitchell Property (45). The Mitchell property, owned by N. Mitchell of Taft, California, is about 8 miles west-northwest of Taft in sec. 2, T. 32 S., R. 22 E., San Luis Obispo County.

Radiation intensities as high as 0.5 MR/hr is caused by autunite in seams or veinlets of gypsum. The gypsum is as much as three-quarters of an inch thick along bedding planes in calcareous siltstone and shale of upper Miocene age. The beds strike N. 61° W. and dip 65° NE. Development of the property consists of several cuts; the largest is 6 feet deep. The richest sample of autunite-bearing gypsum assayed by the U. S. Atomic Energy Commission contained 0.13 percent equivalent uranium and 0.22 percent uranium.

Quality Oil Company Property (46). The Quality Oil Company property is on Sandy Creek, 2 miles southwest of Taft, California, in sec. 22, T. 32 S., R. 23 E., Kern County. Development work consists of a 2-foot cut.

Radiation intensities as high as 0.5 MR/hr are associated with an iron-stained fault breccia in siltstone and shale of late Miocene age. The fault is responsible for accumulation of oil to the southwest. Radioactivity is anomalous in the top 600 feet of nearby oil wells. No secondary uranium minerals were noted in the radio-

active deposit. A sample of silicified iron-stained fault breccia assayed by the U. S. Atomic Energy Commission contained 0.06 percent U_3O_8.

Geeslin and Fiscus Property (47). The Geeslin and Fiscus property, about 3 miles south-southwest of Taft, California, in sec. 34 (?), T. 32 S., R. 23 E., is the site of the initial discovery of uranium in the Taft-McKittrick area of Kern County. The discovery was reported by Irvin Geeslin of Taft, California, during late September 1954.

Abnormal radioactivity, a maximum of 1.0 MR/hr, was detected where yellow secondary uranium minerals, including autunite, coat fractures and bedding planes in siltstone and shale of late Miocene age. The beds strike N. 35° W. and dip 65° NE. The highest grade sample assayed by the U. S. Atomic Energy Commission contained 0.32 percent U_3O_8.

Basin and Range Province

The Basin and Range province of California, which covers most of Mono and Inyo Counties, parts of San Bernardino and Kern Counties, and a small part of Lassen County, is characterized by roughly parallel ranges and intervening valleys or basins which are controlled by faults. The province lies east of the Sierra Nevada, north of the Garlock fault, and is contiguous with the great Basin and Range province of Nevada.

The mountain ranges of the province, including the Inyo, the Argus, and the Panamint Ranges, are underlain predominantly by Paleozoic sedimentary rocks and intrusive masses of granitic rock. The Paleozoic rocks are largely limestone, dolomite, quartzite, and subordinate sandstone and shale. Exposures of pre-Cambrian rocks are extensively exposed in the ranges east of Death Valley. The basins are filled with an appreciable thickness of continental sedimentary deposits of Tertiary to Recent age. Various types of Tertiary volcanic material, ranging in composition from rhyolite to basalt, are extensively exposed both in the valleys and in the mountain ranges.

At the Buckhorn claims, significant concentrations of autunite and possibly other uranium minerals occur in northeast-trending fractures in rhyolitic tuff. Autunite has also been identified tentatively at the Green Velvet claims, where it occurs in clay and tuffaceous sandstone of the Coso formation of Schultz (1937) (Pliocene or Pleistocene age). At the Wild Bill group of claims, small quantities of an unidentified uranium mineral associated with hydrated iron oxides and copper minerals occur adjacent to a quartz fissure vein in quartz monzonite. An unidentified uranium mineral occurs with wulfenite in limestone and dolomite of Paleozoic age which have been intruded by quartz monzonite at the Ubehebe and Lippincott mines. The wulfenite and the uranium mineral occur in oxidized parts of an irregular sulfide replacement deposit in limestone. At the Joe McCulley property, base-metal and silver sulfides are found in the tactite zone between limestone of Mississippian age and an intrusive tongue of granite. Although radioactivity as much as 10 times background has been detected at the property, no uranium minerals have been identified. Anomalous radioactivity has been detected at the Cornelia claims, near the Buckhorn claims in Lassen County, and at the Relich prospect in Mono County, but no uranium minerals have been identified.

Buckhorn Group (6). The Buckhorn group c claims is on the west slope of the Antelope Range the California-Nevada border in secs. 30 and 31, N., R. 18 E., Mt. Diablo meridian, Lassen County fornia, and Washoe County, Nevada. It was loca September 1954 by Ted Delavega and Fred Bar Sparks, Nevada, and A. L. Delavega of Tioga, Dakota. The claims were sold during the latter p 1954 to E. L. Cord of Los Angeles, California. D ment work on the property consists of several bu excavations and surface cuts.

Bedrock exposed in the vicinity of the claims c of granodiorite of Jurassic(?) age overlain by v rocks of Tertiary age of essentially rhyolitic co tion. The volcanic rocks, which strike northwest a moderately to steeply southwest, are described b ald Hetland of the U. S. Atomic Energy Commis three separate lithologic units. The oldest unit, abo feet thick, consists of a light gray to brown rhyoli rock that is rich in biotite. It rests unconforma granodiorite, but is separated in places by metase tary rock (fault gouge ?) about 3 feet thick. A c ized log was seen in metasedimentary rock alon contact. Major fractures in this biotite-rich unit N. 40-60° E. and dip steeply northwest. Autuni possibly other uranium-bearing minerals are erra distributed along closely spaced minor fractures. veinlets of limonitic, siliceous material, as much an inch thick, fill many of these minor fractures a commonly radioactive.

A bed of tuff, approximately 170 feet thick, o the rhyolite flow with an apparently conformabl tact. The tuff contains angular to subangular fra of feldspar, quartz, pumice, rhyolite, andesite possibly basalt.

The youngest lithologic unit consists of a yell brown siliceous rhyolitic tuff. It is separated fr underlying tuff by a fault contact. The principal rence of uranium at the Buckhorn claims is on slope of this youngest unit, where radioactivity m ments are as high as 4.5 MR/hr. Unidentified ur minerals are erratically distributed along thin v of limonite-stained siliceous material. The veinlets from a quarter of an inch to an inch in thickne fill northeast-trending fractures. Grab samples of ish-brown rhyolitic tuff assayed by the Atomic E Commission contained as much as 0.51 percent e lent U_3O_8; the highest grade select sample assa the Commission contained 2.35 percent equivalent

Cornelia Group (5). The Cornelia group of are on the west side of Antelope Range about 7 north of Hallelujah Junction, Lassen County. owned by Ted Delavega and Fred Barker of S Nevada. Anomalous radioactivity as high as 0.5 was measured by the U. S. Atomic Energy Comm over unconsolidated alluvium derived from granit farther to the east. No uranium minerals were ide

Relich Prospect (10). The Relich property miles east of Bodie, California, where the Bodie- (Nevada) highway crosses the state line between County, California, and Mineral County, Nevada: of it lie in both states. It is owned by Dr. Victor El Cerrito, California. No workings are on the pr

ock consists of rhyolite and rhyolitic tuff over adiation intensities as high as 0.11 MR/hr were d by the U. S. Geological Survey. The source of tivity apparently is finely divided radioactive al that is uniformly disseminated throughout the lic rock. Samples collected at points of highest gs measure about 0.03 MR/hr (background: 0.02) when removed from the locality for testing.

Bill (Banner or Dog) Group (12). The Wild oup of claims is in sec. 18, T. 3 S., R. 31 E., about south of Benton, Mono County. It was owned, by the Natural Resources Development Company Gatos, California. Development work consists of dits; the total length of the adits is approximately eet.

claims are underlain by a quartz monzonite intru- at contains numerous inclusions. Within the monzonite, several mineralized quartz veins 6 to 2 feet thick strike northwest and dip at low to the southwest. Faults, which strike approx- N. 25° W. and dip steeply, displace the mineral- ins; displacement on the faults is commonly less feet.

quartz veins contain pyrite, chalcopyrite, galena, e, sphalerite, gold (native ?), and alteration ts of some of these minerals. A 3-inch band of l rock, which is exposed for 5 feet directly be- quartz vein, is appreciably radioactive. Abnor- dioactivity is also found in areas where limonite russite are concentrated. No uranium minerals en identified, but, because of the association with ed iron oxides, it is assumed that the uranium is ly contained in supergene minerals.

samples collected by the U. S. Geological Survey ied as much as 0.1 percent uranium. Samples d by the owners, and assayed by the U. S. Atomic Commission, contained as much as 0.31 percent m.

ebe (13) and Lippincott (14) Mines. The Ube- ine in secs. 1 and 2, T. 14 S., R. 40 E. (projected) e Lippincott mine in sec. 13, T. 15 S., R. 40 E. cted), Inyo County, are about 20 miles northeast ens Lake at an altitude of approximately 4,000 Workings at the Ubehebe mine, principally adits pes, total more than 2,300 feet; workings at the cott mine consist of about 2,000 feet of adits and s. Prior to 1951, the Ubehebe mine yielded over 00 pounds of lead, more than 100,000 pounds of early 35,000 ounces of silver, and some copper lister, 1955). Production records for the Lippin- ine are incomplete; apparently some lead, silver, inor amounts of gold have been produced.

deposits consist essentially of irregular replace- odies and fracture fillings in dolomite of Paleozoic which has been intruded by quartz monzonite, by syenite, and by minette dikes. The ore bodies chiefly of cerussite, hemimorphite, hydrated iron wulfenite, anglesite, silver-bearing galena, and rite.

malous radioactivity is caused by an undetermined m mineral associated with wulfenite in the ore Analysis of samples indicates a uranium content m 0.001 to 0.05 percent.

*Santa Rosa Mine (16).** The Santa Rosa mine is in secs. 26 and 35 (projected), T. 17 S., R. 39 E., Mt. Diablo meridian, in the extreme southern part of the Inyo Mountains, Inyo County. The mine has yielded more than 11,000,000 pounds of lead, more than 450,000 pounds of copper, over 400,000 fine ounces of silver, some zinc, and gold; the ore has been extracted from workings that total about 4,012 feet and from several large stopes.

The mine is in an inlier of silicated limestone † of Permian age bounded by volcanic rocks of Tertiary (?) age. The volcanic rocks include andesite, basalt, and pyroclastic material. The silicated limestone is cut by three andesite porphyry dikes which range from 2 to 3 feet in thickness. Many north-trending veins composed of oxidized lead, zinc, and copper minerals, with minor amounts of sulfides in an iron-rich siliceous gangue, occur in faults in the silicated limestone. The veins range in length from less than 100 feet to about 700 feet, and average between 3 and 4 feet in thickness.

A Geiger-counter survey of the Santa Rosa mine indicates slight anomalous radioactivity in oxidized parts of the veins; the source of the radioactivity is not known.

Green Velvet Claims (15). The Green Velvet group of four claims is owned by Mrs. Olive Cantlay of Olancha, California. It is in sec. 25, T. 19 S., R. 37 E. in the western foothills of the Coso Range, Inyo County.

Bedrock in the vicinity consists of beds of light gray clay, tuffaceous sandstone and arkosic sandstone of the Coso formation of Schultz (1937) (Pliocene or Pleistocene age). The beds dip a few degrees to the southeast at the discovery cut, but have steep dips a mile farther to the southeast where they have been disturbed by faulting.

A maximum radiation intensity of 0.45 MR/hr was measured in the beds of light gray clay and tuffaceous sandstone. Radioactivity appears to be highest beneath a reddish-brown layer of arkosic sandstone which ranges from 2 to 6 feet thick. It ranges from 0.45 MR/hr at the prospect cuts to 0.06 MR/hr half a mile southeast at the same horizon; radioactivity values are spotty. Background count in the vicinity of the claims is 0.015 MR/hr to 0.02 MR/hr. Autunite coats conchoidal fracture surfaces in the light gray clay, but was not observed in the sandstone. A select sample of sandstone assayed by the U. S. Geological Survey, however, contained 0.077 percent uranium. A 4-pound sample of sandstone and limonite submitted to the Geological Survey by Mrs. Cantlay contained 0.12 percent uranium.

Empress Mine. The Empress mine is in sec. 2, T. 19 S., R. 41 E., near the north end of the Argus Range. In 1950 when examined by Everhart and Towle, the property was owned by Joe McCulley of Darwin, California. During the past 20 years, deposits of lead, zinc, copper, and silver have been worked periodically through two small adits.

The deposits are in a roof pendant of limestone of Mississippian age which is enclosed by an upfaulted block of quartz monzonite. The lead, zinc, and copper minerals are in a quartz-rich replacement zone as much as 6 feet thick in the limestone and also in quartz veins in the quartz monzonite.

* Information obtained from E. M. MacKevett (1953).
† An impure limestone that contains at least 20 percent lime silicate minerals.

Table 10. Radioactive samples from California submitted to the U. S. Geological Survey laboratories for assay.

Locality	Submitted by	Sample number	Type	Uranium minerals	Grade (percent)
Imperial County					
Lucky Star claim	S. C. Wright	W657	Kaolin	Carnotite, torbernite	0.24 eU
Unknown	A. I. Obermiller	A10-2	Pegmatite	--------	1.00 eU
Inyo County					
Vic. Olancha	Olive Cantlay	RW-6517	Sandstone and clay	Autunite	0.12 U
Unknown	W. E. Kurshus	RW-5322	Ca carbonate	--------	0.03 U
Unknown	C. W. Lawrence	138442	Contact metamorphic rock	(Thorium-bearing mineral)	0.033 eU, 0.3 U
Kern County					
Red Rock mining dist. vic. Cantil City	A. H. Bishop	RW-5180	Siltstone	--------	0.02 U
5 mi. W. of Rosamond	C. G. Burton	CR789	Rhyolite	Autunite	0.03 U
N½ Sec. 16, T. 32 S., R. 35 E.	G. C. Crawford	RW-7255	Igneous rock	--------	0.06 U
Bean Canyon (Sec. 4, T. 10 N., R. 14 W.)	R. W. Mitchell	RW-7595	Pegmatite	--------	0.02 U
Near Mojave	R. W. Rountree	61709	Altered breccia	--------	0.24 eU, 0.1 U
Near Boron (Vanuray)	C. J. Roycroft	W2923	Limestone	Carnotite	0.08 U
Near McKittrick	C. H. Stineburg	RW-7292	Siltstone and shale	Secondary uranium minerals	0.13 U
Los Angeles County					
Near Palmdale	Mrs. E. Conn	W116	Sandstone, limestone	Carnotite, Nb-Ta mineral	1.30 eU
Mono County					
East of Yosemite Park	W. C. Holding	138722	Contact metamorphic rock	Primary (?) uranium minerals	0.036 eU, 0.1 U
		138723			0.21 eU, 0.2 U
Nevada County					
Vic. Floriston	W. C. McCulloch	200432	Quartz with sulfides	Primary (?) uranium minerals	0.14 eU, 0.1 U
Plumas County					
La Honda mine (near Meadow Valley)	O. J. Hurlbut	205444	Manganiferous and limonitic sinter	(Radium-bearing)	0.16 eU, < 0.43 Ra^{22} 0.31 Rn^{22} 0.28 Pb^{21}
Vic. Chilcoot	P. L. Jones	210512	Quartz vein	Torbernite (?) Zeunerite (?)	0.11 eU, 0.1 U
Feather River Hot Springs T. 25 N., R. 8 E.	F. L. Stowell	W618	Limonite	--------	0.29 eU
Riverside County					
Cottonwood Mountains district (Desert View claim	W. J. Murphy	59331	Biotite gneiss	--------	0.13 eU, 0.1 U
Unknown	A. I. Obermiller	A10-1	Pegmatite (?)	--------	0.36 eU
Unknown	J J. Rakocy	208214	--------	--------	0.037 eU, 0.0 U
Unknown	M. J. Roll	D-98868	--------	Allanite	0.72 eU, 0.7 U
San Benito County					
Vic. Hollister	R. S. Hall	138443	Magnetite-rich rock	--------	0.016 eU, 0.0 U
San Bernardino County					
Rainbow group	G. Alexander	RW-3500	Magnetite, hematite	--------	0.02 U
Black Dog claim	B. Bauer	31979	--------	Allanite, monazite	1.87 eU, 0.61 ThO rare earth
Lucky Star claim, Silver Mountain	Miss M. A. Boughey	W2969	Limestone	--------	0.019 U
Vic. Needles	Oscar Meyer	138800	Pegmatite	Thorium-bearing minerals	0.019 eU, 0
		138801	Granite		0.032 eU, 0
		138802	Magnetite-rich rock		0.044 eU, 0
Summit Diggings	J. M. B. Parry	D-67007	Gray porphyry	Radioactive opal, metatorbernite	0.12 eU, 0.1
25 mi. E. of Barstow (Harvard Hills)	J. W. Vandergrift	W2584	Limestone	Secondary uranium minerals	0.30 eU
San Diego County					
Sec. 21, T. 17 S., R. 8 E.	J. W. Hubble	RW-7330	Igneous rock	--------	0.019 U
Tuolumne County					
Gen. U. S. Grant (Sunnyside) mine	J. C. Powell	RW-3724	--------	Radon gas (?)	--------
Ventura County					
Unknown	J. C. Stevenson, Jr.	W2982	Biotite gneiss	--------	0.032 U
Unknown					
	O. L. Armstrong	RW7462	Quartz w/secondary Cu minerals	--------	0.032 U
	H. J. Barrett	W2989	Sandstone, limestone	Autunite	0.05 U
	S. C. Bedell	W806	Silicified wood	--------	< 0.120 eU
	A. H. Bishop	AW5479, RMW493	Shale	--------	0.054 U
	W. J. Burback	RW7450	Sedimentary rock	--------	0.011 U
	G. T. Clark	W4364, AEC2888	Igneous rock	--------	0.01 U
	K. C. Daulton	RW3437	Conglomerate	--------	0.005 U
	K. C. Daulton	RW3523	Quartz, pyrite, tourmaline	--------	0.006 U
	Guy Dolfi	RW7051	Igneous rock	--------	0.015 U
	W. T. Duggs	W1919	Altered vein material	Minerals of uraninite group	50.0 U
	C. R. Ericson	RW7341	Metamorphic rock	(Thorium-bearing)	0.014 eU, 0.0 U

Table 10. Radioactive samples from California submitted to the U. S. Geological Survey laboratories for assay—Continued.

Locality	Submitted by	Sample number	Type	Uranium minerals	Grade (percent)
ow—Continued	Fresno Geophysical Co.	RW6724	Sedimentary rock w/calcite		0.38 U
	L. W. Gaskins	AW5496, RMW510	Chert, goethite, hematite, w/ quartz, malachite, azurite		0.023 U
	Joe Geiger	RW7224	Igneous rock with Cu minerals		0.037 U
	Joe Geiger	RW6672	Igneous rock		0.018 U
	J. E. Gibson	W2578	Granite gneiss		0.008 eU
	J. J. Goot	AW5573, RMW587			0.028 U
	O. J. Hansen	RW6845	Magnetite sand		0.027 U
	V. R. Harrington	RW6985	Igneous rock		0.057 U
	H. K. Hennigh	W4253, AEC4702	Altered crushed rock w/goc-thite and calcite	(Thorium-bearing)	0.45 eU, 0.034 U
	A. M. Jensen	RW2332	Sandstone, granite, calcite, quartz		0.007 eU
	R. L. Johnson	RW4748	Quartz, heulandite	Meta-autunite	0.083 U
	R. M. Jones	RW6873	Clay		0.025 U
	A. C. Keenan	W1947	Breccia		0.063 eU
	N. G. Keibor	RW7324	Sedimentary rock	Secondary uranium minerals	0.83 U
	M. S. Knight	138705	Sand and silt		0.003 eU
	C. Larzealear	RW7105	Calcareous rock w/azurite and malachite		0.06 U
	J. Leftwich	RW7347	Metamorphic rocks		0.013 eU, 0.007 U
	J. F. Mack	W2910	Weathered granite		0.02 U
	J. F. Mack	W1986	Rhyolite	Secondary uranium minerals	0.015 eU
	C. O. Miller	W2666	Brecciated limestone		0.05 U
	J. E. Moreland	W2657	Lime-silicate rock		0.008 eU
	D. F. Neuschwander	RW7439	Sedimentary rock		0.015 U
	E. Perry	RW4635	Weathered granite	Meta-torbernite	0.025 U
	R. J. Pixler	RW7182	Sedimentary rocks w/inala-chite and azurite		0.048 U
	T. Pratt	RW6747	Magnetite		0.17 U
	H. L. Rogers	RW6164	Quartz, galena, pyrite		0.046 U 0.013 U
	G. P. Steffen		Limestone	Meta-tyuyamunite	0.26 U
	J. Stevenson, Jr.	W8016	Metamorphic rock		0.025 U
	C. M. Stradal	RW7050	Weathered igneous rock w/ limonite		0.02 U
	C. S. Tessier	RW6991	Weathered sandstone		0.46 U
	E. Tucker	RW2076	Gneiss		0.008 eU
	L. J. Urac	RW5156	Igneous rock		0.026 U
	H. M. Valencia	W1968	Coal, arkose		—0.01 eU
	J. D. Varis	RW6837	Igneous rock w/calcite		0.03 eU, 0.003 U
	E. Wagnon	RW7211	Limonite		0.007 eU, 0.08 U
	W. H. Wolcott	W2905-1	Quartz, chalcopyrite, limonite		0.03 eU
	T. Wood	138798	Pegmatite		0.017 eU, 0.014 U
	M. E. Wright	W4347, AEC4978	Igneous rocks w/secondary Cu minerals		0.012 U

rverses in the underground workings in the replace- t one detected radioactivity as much as 10 times ground. No uranium minerals have been identified property.

Other Reported Occurrences of Uranium and Thorium Minerals

currences of thorium and uranium minerals have ported from a number of other localities in Cali- a few of which already have been studied briefly U. S. Geological Survey or the U. S. Atomic Commission. Of these, the uranium- or thorium- minerals are present in such small amounts that ould be considered a potential source of either ium or thorium under present conditions.

onazite has been reported in placer concentrates in ravels at Placerville and the Indian Diggings in Dorado County, at Trinidad in Humboldt County, Michigan Bluff in Placer County, in the Browns- district in Yuba County, and at unspecified local- Butte, Nevada, and Plumas Counties (Murdoch Webb, 1948). Monazite has been reported in placer etrates from the Ogilby district, Cargo Muchacho rains, from the San Joaquin River near Friant, om the Tuolumne River near La Grange. Monazite has also been reported in Pacific beach sands near Crescent City in Del Norte County (Murdoch and Webb, 1948), and in the backshore zone of beaches in San Mateo County (Hutton, 1951b). Monazite occurs in pegmatites at the following places in Riverside County: Mesa Grande, 2 miles north of Winchester, near the Vonsen limestone quarry, and the Southern Pacific quarry near Nuevo (Chesterman, 1950). Weak gamma-ray activity, probably caused by thorium in monazite, has been found on the Original and Pack Saddle claims about 4 miles east-northeast of Amboy in San Bernardino County. The monazite (?) is an accessory constituent of granitic rocks. Other localities, in which minute amounts of torbernite, cyrtolite, samarskite (?), and xenotime have been reported, also are listed by Murdoch and Webb (1948).

Thorite has been found in placer gravels along the Feather, Yuba, American, Mokelumne, Tuolumne, and Merced Rivers (George, 1951). Allanite, which may or may not be radioactive, has been reported from the Ford mine, Calaveras County, from the Eagle Mountain iron deposits, Riverside County, from the Gassenberger Ranch, Tulare County, and elsewhere (Murdoch and Webb, 1948).

In 1952, G. W. Moore and J. G. Stephens of the U. S. Geological Survey conducted a reconnaissance in California in search of new deposits of uranium-bearing carbonaceous rock. During the investigation, 50 localities were examined, including 46 that contain coal or carbonaceous shale and 4 that contain petroliferous material. A total of 63 samples of carbonaceous rocks were taken for analysis from 38 of the localities. The uranium content of the samples ranges from less than 0.001 percent to a maximum of 0.020 percent. The most significant concentrations of uranium in carbonaceous rocks in California are: Newhall prospect, Los Angeles County, 0.020 percent uranium; Fireflex mine, San Benito County, 0.005 percent uranium; American lignite mine, Amador County, 0.004 percent uranium; and Tesla prospect, Alameda County, 0.003 percent uranium.

Positive fluorescent bead tests for uranium in base metal-quartz veins in rhyolites in the Wingate Pass area in Inyo County have been reported; the area is about 83 miles northwest of Baker, near Death Valley. Geiger counter readings in the area, however, averaged only 7 counts per minute above background. The uranium content is too low to be of further interest.

Weak radioactivity occurs erratically in mineralized shear zones on the Alpha, Beta, and Gamma (31) claims in San Bernardino County about 10 miles northwest of Johannesburg. The shear zones contain minor amounts of pyrite, secondary copper minerals, hydrated iron oxides, gypsum, and an unidentified radioactive mineral.

Reconnaissance of the Grimes Canyon area (71), Ventura County, indicates the presence of minor amounts of an unidentified radioactive material associated with volcanic rocks of mid-Tertiary age. The volcanic rocks are interstratified with sedimentary rocks of mid-Tertiary age that they may locally intrude. Throughout most of the area, Geiger counter readings are the same as, or only slightly above, background count; however, locally, readings as much as three times background have been recorded.

On October 6, 1949 the Mariposa Gazette published an article on the discovery of uranium in the Mother Lode district by Dr. F. E. Tiffany of Mid Pine, California. Dr. Tiffany was contacted by geologists of the U. S. Atomic Energy Commission; he stated that the deposit was in Yosemite National Park about 28 miles from Mid Pine, but was inaccessible at the time. He further stated that the deposit consisted of calciocarnotite (tyuyamunite), specimens of which contained as much as 4.0 percent U_3O_8. This material was reported to occur in a clay seam 4 to 8 inches wide and approximately 400 feet long, between granite and slate.

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